Ligaments

Cervical Spine

Between Vertebral Bodies

**Anterior Longitudinal Ligament**
- Supports the vertebral column and discs
- The deep fibres connect adjacent vertebrae
- The superficial fibres extend across several vertebrae

**Posterior Longitudinal Ligament**
- The deep fibres connect adjacent vertebrae
- The superficial fibres extend across several vertebrae
- Fibres only connect to the intervertebral discs and adjacent margins
- The posterior ligament is considerably weaker than the anterior ligament
- The ligament is thicker when over the intervertebral discs

Zygapophyseal Joint

**Ligamentum Flavum**
- Passes from the laminae of adjacent vertebrae
- Present bilaterally
- Ossification or hypertrophy of this ligament can cause spinal stenosis

**Supraspinous Ligament**
- Runs across and connects the spinous processes
- Merges with the Ligamentum Nuchae in the cervical spine

**Ligamentum Nuchae**
- Runs from the spinous process of C7 to the external occipital protuberance
- Attaches to each spinous process

**Interspinous Ligament**
- Small ligament that joins adjacent vertebral spines
**Atlantoaxial Joint**

**Accessory atlantoaxial ligament**
- Restraint over the lateral atlantoaxial joint
- Passes obliquely downward and medially from the lateral mass of the atlas to the back of the axis
- Merges with the posterior joint capsule of the lateral atlantoaxial joint

**Transverse ligament of the atlas**
- Arising from the medial tubercles on the inner aspect of the arch of the atlas
- Two further longitudinal bands of fibres that descend superiorly and inferiorly to attach to the foramen magnum and the back of the body of the axis respectively.
- Prevents anterior translation of atlas on axis which could cause compression of structures located in spinal canal by the dens of the Axis

**Tectorial Membrane**
- Superior extension of the posterior longitudinal ligament
- Covers the dens and its ligaments
- Protects the spinal cord and medulla

**Alar ligament**
- Passes obliquely superiorly and laterally from each side of the apex of the dens to the medial aspect of the occipital condyles.
- Restricts excessive rotation of the atlantoaxial joint

**Apical ligament of the dens**
- Passes superiorly from the apex of the dens to the foramen magnum

**Atlanto-occipital Joint**

**Anterior atlanto-occipital membrane**
- Passes from the anterior arch of the atlas to the anterior margin of the foramen magnum on the base of the skull
- The lateral margins merge with the anteromedial joint capsule

**Posterior atlanto-occipital membrane**
- Passes from the upper border of the posterior arch of the atlas to the posterior margin of the foramen magnum
- The ligament blends with the posteromedial aspect of the joint capsule
Arthrokinematics and Joint Orientation

Joint Orientation

Cervical Spine

C0- C1

Occiput
- Convex occipital condyles

Atlas
- Concave superior articular facets
- Face superior, anterior and medial

C1- C2

Atlas

Inferior Articular Facets
- Articulate with superior facets of axis
- Convex
- Face inferiorly and medially

Anterior Arch of Atlas (on posterior aspect)
- Articulates with the dens
- Concave
- Face posteriorly

Axis

Superior Articular Facets
- Articulates with inferior articular facets of atlas
- Convex
- Face superiorly and laterally

Anterior Dens Facet
- Articulates with anterior arch of atlas
- Convex

Posterior Dens Groove
- Articulates with the transverse ligament of atlas
• Concave

**C3 - C7**

*Superior Articular Facets*
• Articulates with inferior articular facet of the superior vertebrae
• Face superiorly, posteriorly and medially

*Inferior Articular Facets*
• Articulates with the superior articular facet of inferior vertebrae
• Faces inferiorly, anteriorly and laterally
• Becomes more oblique further down cervical spine so that it is almost vertical at the thoracic spine

**Joint Orientation - Thoracic Spine**

**T1 – T11**

*Superior Articular Facets*
• Convex
• Face posteriorly, slightly superiorly and laterally

*Inferior Articular Facets*
• Concave
• Face anteriorly, slightly inferiorly and medially

**T12**

*Superior Articular Facets*
• Thoracic like
• Convex
• Face posteriorly, slightly superiorly and laterally

*Inferior Articular Facets*
• Lumbar like
• Convex
• Face laterally and anteriorly
**Joint Information**

**Capsular Pattern**
The limitation of movement in a defined pattern which usually indicates arthritis. It can indicate degenerative, inflammatory or traumatic arthritic symptoms. The movements usually take on a ‘hard’ end feel rather than a normal elastic capsular resistance. Involuntary muscle spasm occurs to protect a painful joint, preventing painful ranges of movement. Ranges of movement that are underused become limited as the capsule contracts disproportionately. This causes a gross limitation of certain movements giving rise to a distinct pattern.

**End Feel**
End feel is the specific sensation felt in the therapist’s hands at the end of range passive movements. Normal end feels have been divided into three categories

- **Hard End Feel** - bone on bone contact
- **Soft End Feel** - soft tissue on soft tissue contact
- **Elastic End Feel** - passive tension of inert structures around the joint

If an injury has occurred end feels can be divided again into 3 abnormal end feel categories

- ‘Hard’ End Feel- Involuntary muscle spasm can protect a joint giving a ‘hard’ end feel. A ‘hard’ end feel can also be the result of capsular resistance. Finally a ‘hard’ end feel can be due to bone on bone contact in end stage arthritis symptoms where a soft or elastic end feel would normally be detected.

- **Springy End Feel** - usually the result of a mechanical joint displacement or loose body. There is usually a small restriction in joint range with the joint springing or bouncing back.

- **Empty End Feel** - usually associated with serious pathology or a highly irritable injury. Therapist is unable to test end of range as patient halts the movement with voluntary muscle spasm

**Resting Position**
This is the position in which the joint is under the least amount of stress. This allows joint play to be assessed easily. This position results in decreased contact areas for the joint surface providing proper joint lubrication and allows complete arthrokinematics at the joint.

**Close Packed Position**
In this position the joint is under maximal tension and the joint surface is fully congruent. This position is often painful for a joint that is swollen.
### Arthrokinematics - Cervical Spine

<table>
<thead>
<tr>
<th>Capsular Pattern</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting Position</td>
<td>Slight Flexion</td>
</tr>
<tr>
<td>Close Packed Position</td>
<td>Full Extension</td>
</tr>
<tr>
<td>End Feel</td>
<td>See C2 – C7</td>
</tr>
</tbody>
</table>

**Movements**
- Flexion - occipital condyles glide posteriorly, roll anteriorly
- Extension - occipital condyles glide anteriorly, roll posteriorly
- Rotation - ipsilateral glide of occiput with contralateral flexion of occiput due to alar ligament tension
- Lateral flexion – ipsilateral glide of occipitals condyles

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<tr>
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<tr>
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<td>See C2 – C7</td>
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</tbody>
</table>

**Movements**
- Flexion - inferior articular surface of lateral mass of atlas rolls anteriorly, glides posteriorly
- Extension - inferior articular surface of lateral mass of atlas rolls posteriorly, glides anteriorly
- Rotation - dens remain static. Atlas rotates towards side of rotation. At the lateral atlantoaxial joint the inferior surface of the ipsilateral lateral mass slides posteriorly while the contralateral lateral mass slides anteriorly.

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<table>
<thead>
<tr>
<th>Capsular Pattern</th>
<th>Lateral flexion and rotation equally limited</th>
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<td>Slight Flexion</td>
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<tr>
<td>Close Packed Position</td>
<td>Full Extension</td>
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</tbody>
</table>

**End Feel**
- Flexion - **ELASTIC - STRETCHING** of posterior ligaments, posterior annulus of disc, zygapophyseal joint capsules and posterior cervical musculature. **SOFT - IMPACT** of submandibular tissues against throat.
- Extension - **ELASTIC – STRETCHING** of anterior annulus of disc, zygapophyseal joint capsules and anterior cervical musculature. **HARD - IMPACT** of spinous processes
- Lateral flexion - **ELASTIC – STRETCHING** of intertransverse ligaments, lateral annulus of disc, contralateral longus capitis, longus colli, anterior scalenes and sternocleidomastoid
- Rotation - **ELASTIC – STRETCHING** of alar ligaments, zygapophyseal joint capsules, contralateral longus capitis, longus colli, anterior scalenes and ipsilateral sternocleidomastoid

**Movements**
- Flexion - upper vertebrae rolls anteriorly and glides anteriorly
- Extension - upper vertebrae rolls posteriorly and glides posteriorly
- Lateral flexion - always occurs with same side rotation, ipsilateral inferior articular surface of superior vertebrae glides posteriorly and inferiorly
- Rotation - always occurs with same side lateral flexion, inferior articular surface of superior vertebrae on contralateral side moves against superior articular surface of
inferior vertebrae, this creates a chamber and increases the size of the intervertebral foramen

## Thoracic Spine

<table>
<thead>
<tr>
<th>Capsular Pattern</th>
<th>Lateral flexion and rotation equally limited, then Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting Position</td>
<td>Midway between Flexion and Extension</td>
</tr>
<tr>
<td>Close Packed Position</td>
<td>Extension</td>
</tr>
<tr>
<td><strong>End Feel</strong></td>
<td></td>
</tr>
<tr>
<td>• Flexion – ELASTIC – <strong>STRETCHING</strong> of posterior longitudinal ligament, ligamentum flavum, supraspinous and interspinous ligaments, posterior fibres of the annulus and the zygapophyseal joint capsules and posterior musculature</td>
<td></td>
</tr>
<tr>
<td>• Extension – ELASTIC – <strong>STRETCHING</strong> of the anterior zygapophyseal joint capsules, anterior annulus, rectus abdominis, internal and external obliques. HARD – <strong>IMPACT</strong> of spinous processes and zygapophyseal facets</td>
<td></td>
</tr>
<tr>
<td>• Lateral flexion – ELASTIC – <strong>STRETCHING</strong> of the contralateral annulus, zygapophyseal joint capsules, intertransverse ligaments, thoracolumbar fascia, internal and external obliques and posterior musculature. HARD – <strong>IMPACT</strong> of ipsilateral zygapophyseal facets</td>
<td></td>
</tr>
<tr>
<td>• Rotation – ELASTIC – <strong>STRETCHING</strong> of the contralateral annulus and zygapophyseal joint capsules, costotransverse and costovertebral joint capsules, supraspinous, interspinous and iliolumbar ligaments, rectus abdominis, internal and external obliques, multifidus, semispinalis thoracis and rotatores. HARD – <strong>IMPACT</strong> of zygapophyseal facets</td>
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<td></td>
</tr>
<tr>
<td>• Lateral flexion- occurs with same side rotation, contralateral inferior articular surface of superior vertebrae glides superiorly and rolls anteriorly, ipsilateral inferior articular surface of superior vertebrae glides inferiorly and rolls posteriorly</td>
<td></td>
</tr>
<tr>
<td>• Rotation- inferior articular surface of superior vertebrae glides away from superior articular surface of inferior vertebrae</td>
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**Coupling**
Coupling refers to a movement at a joint that occurs in combination with a different movement around a separate axis. Coupling occurs at all joints throughout the spinal column except the atlanto-axial joint.

Coupling can be categorised into 3, depending on ‘Fryette’s Law’

**Law 1** – Neutral side bending produces rotation to the other side.

**Law 2** - Non Neutral rotation and side bending go to the same side

**Law 3** - Introducing motion in one vertebral joint in one plane automatically reduces its mobility in the other two planes

**Coupling - Cervical Spine**

**C0**- **C1**
Rotation and lateral flexion occur to opposite sides.

**C1**- **C2**
These is currently a discrepancy within the literature as to the coupling that occurs here.

**C2**- **C7**
Rotation and lateral flexion occur to the same sides.

**Cervical Spine Biomechanics**
The below relates to the coupling motion that occurs between the Upper Cervical Spine and Lower Cervical Spine.

In general, whatever happens at the Lower Cervical Spine, the opposite happens at the Upper Cervical Spine.

**Protraction**
Lower Cervical (C2-C7) Flexion

Upper Cervical (C0-C2) Extension

**Retraction**
Lower Cervical Extension

Upper Cervical Flexion

**Rotation**
Lower Cervical Rotation
C0-C1 Lateral Flexion in Opposite Direction

**Lateral Side Flexion**
Lower Cervical Lateral Flexion

C1-C2 Rotation in Opposite Direction

**Spinal Locking**
Spinal locking is necessary when performing long-level high-velocity low-amplitude (HVLA) thrusts. In order to do this the spine must be placed in a position opposite to its normal coupling behaviour.

**Spinal Locking- Cervical Spine**

**C2-C7**
Locking is achieved with cervical rotation and side bending to opposite sides.