Upper cervical spine injuries C1/C2 instability.

Normal and pathological findings : X-Rays, CT, MRI

Jean-Claude.Dosch @Chru-Strasbourg.Fr

No funds were received in support of this study.
Several methods describe the spatial relationship between the occiput, atlas and axis.

These radiographic measurements, are often difficult to use in the traumatic setting because of their complexity and difficulty with visualizing pertinent anatomic landmarks.

They can be used with more success on MSCT.
Radiological landmarks
(lateral view)
Chamberlain's line

- $4 < d < 12$

Harris's BDI and BAIs

- $d < 3mm$

Power's ratio

- $R = AB / CD < 1$

Lee's lines

- $d < 3mm$
Radiological landmarks

*(frontal « open mouth » projection)*

1. Fischgold’s line
2. Wackenheim intervestibular’s line
Ligamentous structures
Pure ligamentous instability
- Atlanto-dental dislocation
- Rotatory fixation

Osseous and ligamentous instability
- Odontoid’s fracture
- Pedicle’s fracture of the axis
- Jefferson’s fracture
Pure ligamentous instability
- Atlanto-dental dislocation
- Rotatory fixation

Osseous and ligamentous instability
- Odontoid's fracture
- Pedicle’s fracture of the axis
- Jefferson’s fracture
Anterior atlanto-dental dislocation
(rupture of the transverse atlantal ligament)

Dickman CA, Sonntag VK
Injuries involving the transverse atlantal ligament: classification and treatment guidelines based upon experience with 39 injuries.
Neurosurgery. 1997
Radiographics findings

Atlanto dental space

Normal
In neutral and extension position

Pathol > 5 mm
In flexion
Pure ligamentous instability

- Atlanto-dental dislocation
- Rotatory fixation

Osseous and ligamentous instability

- Odontoid’s fracture
- Pedicle’s fracture of the axis
- Jefferson’s fracture
Normal findings in rotation
(Inferior view)
Normal findings in rotation
(suprior view)
.....respect of the alar, cruciate and transverse ligaments
Cook Robin’s position, torticolis, rotatory fixation?

a three-position computed tomography diagnostic protocol

<table>
<thead>
<tr>
<th>Characteristics of $C_1C_2$ motion</th>
<th>Interpretation</th>
<th>Designation</th>
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</thead>
<tbody>
<tr>
<td>Reduction of $C_1C_2$, $\leq 20^\circ$; near horizontal motion curve</td>
<td>AARF</td>
<td>Type I AARF</td>
</tr>
<tr>
<td></td>
<td>Bony interlock</td>
<td></td>
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<tr>
<td></td>
<td>Most severe stickiness</td>
<td></td>
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<tr>
<td>Reduction of $C_1C_2$, $&gt; 20^\circ$; curve slopes down from right to left but never crosses x axis, $C_1$ never crosses $C_2$</td>
<td>AARF</td>
<td>Type II AARF</td>
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<tr>
<td></td>
<td>Not bony locked, but very unyielding stickiness</td>
<td></td>
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<tr>
<td>$C_1$ crosses $C_2$ (curve cuts x axis) left of $C_1 = -20^\circ$, far away from normal null point of rotation at $0^\circ$</td>
<td>AARF</td>
<td>Type III AARF</td>
</tr>
<tr>
<td></td>
<td>Moderate pathological stickiness</td>
<td></td>
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<tr>
<td>Motion conforms to physiological motion curve</td>
<td>Normal $C_1C_2$ rotational dynamics</td>
<td>Muscular torticollis</td>
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<tr>
<td>Curve slightly left of physiological motion curve, $C_1$ crosses $C_2$ between $-8^\circ$ and $-20^\circ$</td>
<td>Severe spasm and mild joint stickiness. Usually not AARF, but few may convert to Type III AARF</td>
<td></td>
</tr>
</tbody>
</table>
An average of 64° of rotation narrows the canal to 1cm (size of the spinal cord)

Risk of spinal cord injury

Radiological findings

Fielding’s classification is supported by the aspect of the atlanto-dental space.
Fielding and Hawkins

Normal atlanto-dental space

Type I

All ligaments are intact

But remind the need of a flexed position!
Fielding and Hawkins

3mm < Atlanto dental space < 5mm

Deficiency of the transverse ligament
Facet joint deformity and lateral inclination observed on 3D CT reconstructions can be useful signs to predict the prognosis and the treatment of choice in patients with chronic AARFs.

Fielding and Hawkins

Type III

Atlanto dental-space > 5mm

Deficiencies of the transverse ligament and alar ligaments

Type IV

Deficiency of the dens is required to allow posterior shifting of the atlas on the axis
Pure ligamentous instability
  - Atlanto-dental dislocation
  - Rotatory fixation

Osseous and ligamentous instability
  - Jefferson’s fracture
  - Odontoid’s fracture
  - Pedicle’s fracture of the axis
Jefferson’s fracture
Instable Jefferson’s fracture

Offset = \( d^R + d^L \)

Offset > 6mm

rupture of the transverse ligament (Spence)
Pure ligamentous instability
  - Atlanto-dental dislocation
  - Rotatory fixation

Osseous and ligamentous instability
  - Jefferson’s fracture
  - Odontoid’s fracture
  - Pedicle’s fracture of the axis
Instable dens’s fracture
OBAR Dens fracture

Anterior longitudinal ligament’s rupture
Pure ligamentous instability
  - Atlanto-dental dislocation
  - Rotatory fixation

Osseous and ligamentous instability
  - Jefferson’s fracture
  - Odontoid’s fracture
  - Pedicle’s fracture of the axis
Instable pedicle’s fracture

Day 1

Day 21
Instable pedicle’s fracture

Effendi
Levine
Type II

- Dynamic exploration or MRI

\[ \alpha > 11^\circ \]

\[ t > 4 \text{mm} \]
Stable
disc and ligament intact

Unstable
disc and ligament injured
Conclusion 1

C1 / C2 instability

is the reflect

of a ligamentous injury
Conclusion 2

X-Ray : indirect signs of instability

CT : gold standard for the osseous lésions

MRI : direct signs of instability
Thank you for your attention