Rheumatoid Arthritis and the Cervical Spine

Radiology Rounds
November 21, 2006
Derek Haaland
Rheumatoid Arthritis &
the Cervical Spine

- RA is the most common inflammatory disorder of the spine
- Garrod first report C-spine involvement in 178 of 500 RA patients in 1890
- Risk factors for cervical involvement:
  - Males
  - RF
  - Peripheral activity
  - Corticosteroid use
- In RA:
  - Neck pain 40 to 88%
  - Cervical subluxation 43 to 86%
  - Neurologic compromise 7 to 34%
- Up to 86% of RA patients have C-spine involvement*
- 50% of patients with radiographic instability are asymptomatic
- In a postmortem study of 104 RA patients, 10% of deaths were attributed to medullary compression
- Occipito-Atlanto and Atlanto-Axial joints predominantly affected because they are purely synovial
- Further, the lateral Atlanto-Axial joints are oriented in the axial plane, with no bony interlocking to prevent subluxation in the face of ligamentous or capsular destruction

Rheumatoid Arthritis & the Cervical Spine

- Atlanto-axial subluxation represents 65% of all cervical subluxations
- Of these majority anterior, 20% lateral and 7% posterior; rotatory rare
- Can be reducible, partially reducible or fixed
- Superior migration of the odontoid (cranial settling/atlanto-axial impaction/pseudobasilar invagination) is the second most common RA spine deformity – seen in 20% of pts
- Subaxial subluxation occurs in ~ 15% of patients

Figure 1 Classification of rheumatoid cervical spine changes. In aAAS (anterior atlanto-axial subluxation > 3 mm) the atlas moves abnormally forward due to laxity of the transverse ligament. AAI (atlanto-axial impaction) results from inflammatory changes in lateral atlanto-axial joints. Erosions in the atlanto-odontoid joint or fracture of the odontoid are seen as pAAS (posterior atlanto-axial subluxation). Unilateral atlanto-axial joint involvement causes the atlas to move to the opposite side, a subluxation known as IAAS (lateral atlanto-axial subluxation > 2 mm). Rotational atlanto-axial subluxation indicates a fixed and nonreducible rotation of atlas with respect to axis. Lateral mass collapse connected with tilt to the same side is called NRRHT (nonreducible rotational head tilt). Subluxation of a vertebra below the C2 level forms SAS (subaxial subluxation > 2 mm). Apophyseal joint ankylosis is detected most commonly between the C2 and C3 vertebrae.
Table 1 Prevalence (%) of Subluxations of the Cervical Spine in Various Rheumatic Diseases

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Rheumatoid Arthritis</th>
<th>Ankylosing Spondylitis</th>
<th>Psoriatic Arthritis</th>
<th>Juvenile Chronic Arthritis*</th>
</tr>
</thead>
<tbody>
<tr>
<td>aAAS</td>
<td>23–38 (3–5)</td>
<td>4–21 (6–9)</td>
<td>5–23 (10–12)</td>
<td>17–20 (13, 14)</td>
</tr>
<tr>
<td>AAI</td>
<td>26–28 (3–5)</td>
<td>2–7 (8, 9)</td>
<td>2–5 (10–12)</td>
<td>25 (14)</td>
</tr>
<tr>
<td>pAAS</td>
<td>0–4 (3–5)</td>
<td>1 (9)</td>
<td>0 (12)</td>
<td></td>
</tr>
<tr>
<td>IAAS</td>
<td>6–18 (3–5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotatory AAS</td>
<td>14 (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRRHT</td>
<td>10 (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAS</td>
<td>7–26 (3–5, 15)</td>
<td>0 (9)</td>
<td>3–16 (10, 12)</td>
<td>5–6 (13, 14)</td>
</tr>
<tr>
<td>Apophyseal joint ankylosis</td>
<td>11 (16)</td>
<td>44–45 (7, 9)</td>
<td>0–11 (10, 12)</td>
<td>41–52 (13, 14)</td>
</tr>
</tbody>
</table>

*Figures are based on population or hospital cohorts. The number and the severity of the changes increase with the increasing inflammatory activity and duration of the disease except that the prevalence of aAAS may decline as AAI progresses. aAAS = anterior atlantoaxial subluxation, pAAS = posterior AAS, IAAS = lateral AAS, AAI = atlantoaxial impaction, NRRHT = nonreducible rotational head tilt, SAS = subaxial subluxation.
†Includes patients with juvenile rheumatoid arthritis.
Numbers in parenthesis are reference numbers.
Natural History

• Cranial settling almost always preceded by AAS

• In a 12 year study of 41 patients with AAS
  – 88% progressed
  – Of the remainder 80% had cranial settling!

• Myelopathy associated with 50% one year mortality in one study

Clinical

- Suboccipital pain common but nonspecific
- Weakness/decreasing function warrants high index of suspicion (31 week delay in one study b/t symptoms and myelopathy Dx)
- Vertebrobasilar insufficiency

RA C-spine: radiography

• Initial radiographic assessment should include:
  – Lateral dynamic flexion/extension views
  – Anterior/posterior/lateral static views

• Repeat q2-3 years esp. in pts requiring intubation or with new symptoms

AAS Measurements

- **Anterior Atlantodental interval (AADI)**
  - Lateral radiograph
  - Posterior aspect of anterior ring of Atlas to anterior dens
  - Normal < 3mm
  - Increases on flexion with instability
  - Surgery if 8-10mm (although poor predictor of neurologic dysfunction)

- **Posterior Atlantodental interval (PADI)**
  - Posterior dens to anterior aspect of lamina of Atlas
  - Among 73 patients Boden et al. (1993) found PADI ≤ 14mm 97% sensitive for paralysis (but 94% false positive rate!); AADI did not correlate

Fig. 3 – Normal cervical spine radiograph demonstrating how the anterior atlanto-dental interval AADI (between open arrows) and the posterior atlanto-dental interval PADI (black arrow heads) are measured.
Fig. 2 – Anterior atlanto-axial subluxation. The drawing shows forward subluxation of the atlas on the axis, pannus formation around the odontoid process and osseous erosions. There is compression of the spinal cord between the pannus anteriorly and the posterior arch of the atlas (Reproduced, with permission, from Boden et al. [1]).
Figure 4 Radiographs of the upper cervical spine in a patient with rheumatoid arthritis. Anterior atlanto-axial subluxation (5 mm) is seen in flexion of the neck (a), but disappears in extension (b). Anterior view of occipito-atlanto-axial junction of the same patient (c) demonstrates the lateral atlanto-occipital joints and atlanto-axial facet joints on both sides of the dens of the axis.
Figure 4 Radiographs of the upper cervical spine in a patient with rheumatoid arthritis. Anterior atlanto-axial subluxation (5 mm) is seen in flexion of the neck (a), but disappears in extension (b). Anterior view of occipito-atlanto-axial junction of the same patient (c) demonstrates the lateral atlanto-occipital joints and atlanto-axial facet joints on both sides of the dens of the axis.
AAI/Basilar Invagination
Measurements:

• 1) Clark Station
• 2) Ranawat Criterion
• 3) Redlund-Johnell measurement

• Riew and colleagues (2001) examined lateral C-spine plain film vs. tomography/CT/MRI as gold standard in 67 RA patients in the assessment of basilar invagination
  - Test characteristics of 8 plain film diagnostic methods were evaluated

Diagram showing a lateral view of the cervical spine with relevant landmarks.
1) Clark station

Figs. 2-A and 2-B Clark station. The station of the first cervical vertebra is determined by dividing the odontoid process into three equal parts in the sagittal plane. If the anterior ring of the atlas is level with the middle third (station II) or caudal third (station III) of the odontoid process, basilar invagination is diagnosed. Fig 2-A Line diagram.
2) Redlund-Johnell Criterion

Figs. 3-A and 3-B Redlund-Johnell criterion. The distance between the McGregor line and the midpoint of the caudal margin of the second cervical vertebral body is measured. A measurement of less than 34 mm in males and less than 29 mm in females indicates basilar invagination.

Fig. 3-A Line diagram.
3) Ranawat Criterion

Fig. 4-A

Figs. 4-A and 4-B Ranawat criterion². The distance between the center of the second cervical pedicle and the transverse axis of the atlas is measured along the axis of the odontoid process. A measurement of less than 15 mm in males and less than 13 mm in females is indicative of basilar invagination. Fig. 4-A Line diagram.
Basilar Invagination

- If any one method positive -> considered as positive test:
  - Sensitivity 94%
  - NPV 91%
  - PPV 56%

Fig. 4 – Gross anterior atlanto-axial subluxation shown on lateral radiograph of neck in flexion. The odontoid is completely eroded. The estimated AADI is 10 mm and the PADI is approximately 9 mm.
Fig. 3. Lateral radiograph demonstrating subaxial subluxation of the cervical spine at multiple levels, resulting in the classic “stepladder” deformity.
Indications for surgery

- **Clear indications:**
  - Intractable pain and/or neurologic deficit

- **“Preventive” surgery in AAS:**
  - Cervical collars do not prevent AAS progression
  - PADI < 14mm -> MRI
  - If space available for the cord (SAC) <13mm consider surgery

Indications for surgery

• “Preventive surgery” in cranial settling:
  – Cranial settling on plain films -> MRI
  – Cord compression -> surgery

• “Preventive surgery” in SAS:
  – Posterior canal diameter < 14mm -> MRI
    • SAC < 13mm or
    • segmental mobility > 3.5mm -> surgery

• Nguyen et al. Spine J. 2004:4;329.
• Shen et al. Spine J. 2004:4;689.
Figure 4 Radiographs of the upper cervical spine in a patient with rheumatoid arthritis. Anterior atlanto-axial subluxation (5 mm) is seen in flexion of the neck (a), but disappears in extension (b). Anterior view of occipito-atlanto-axial junction of the same patient (c) demonstrates the lateral atlanto-occipital joints and atlanto-axial facet joints on both sides of the dens of the axis.
Figure 2 The atlas (vertebra) in anterior (a), lateral (b), and cranial view (c). 1 = anterior tubercle, 2 = transverse process, 3 = anterior arch, 4 = posterior arch, 5 = lateral mass, 6 = posterior tubercle, 7 = superior articular facet.