Ankylosing Spondylitis
Axial manifestations

Radiology Rounds
St. Joseph Hospital

By:
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McMaster University
Briefly about A.S

- Seronegative arthropathy of unknown origin
- Young adults
- More severe in males
- 0.1-1% prevalence
- Central Europe highest prevalence
- 90% HLA B27

SKELETAL MANIFESTATIONS OF ANKYLOSING SPONDYLITIS

Sites of enthesopathy
Insidious onset of low back pain
- Early 3rd decade of life
- Sacroiliitis:
  - Commonly seen at presentation
  - Bilateral symmetric
- Chiefly disease of axial skeleton
Characteristic radiographic changes in ankylosing spondylitis

- Seen first in axial skeleton
- More prominent in:
  - sacro-iliac and
  - disco-vertebral apophyseal joints
- Costco-vertebral and costo-transverse joints as well
- Change evolves slowly over many years
Time from first symptom to first radiographic findings

?
- Time from first symptoms to observing plain X-ray findings
  - 9 years

- Earliest radiographic findings → SI joint
Radiographic studies

- No radiographic method ideal b/o complex individual variations of SI joint
- Interpretation of early sacroilitis difficult b/o:
  - Presence of degenerative changes
  - Not appropriate view
  - Best view with plain x-ray → Ferguson’s view
    - (AP view, pelvis, aimed at 30° cephalad)
**X-Ray findings**

- **Mineralization:**
  - Normal before ankylosis
  - Generalized osteoporosis after ankylosis

- **Subchondral bone formation**
  - Present before ankylosis
SI joint x-ray findings ...

- **Erosions**
  - Progressive subchondral bone erosions
  - *pseudowidening*
  - Small and localized
  - Not very prominent

- **Pattern:**
  - bilateral and symmetric
  - First on the iliac side
  - Then on sacral side
    - Appearance of *edge of postage stamp*
    - Erosions surrounded by “bone repair” \(\rightarrow\) *sclerosis*
  - First seen in lower 3\(^{rd}\) (Synovial part)
Axial X-Ray findings ...

- **Ankylosis**
  - Distributions:
    - First → SI joint and lumbar
    - Ascending from lumbar to cervical
    - Involvement of costovertebral Joints

- Absence of subluxations
- Absences of cysts
Ankylosing Spondylitis: early sacroiliitis
Ankylosing spondylitis: advanced sacroiliitis
The Spine

- Initially → T12-L1 area
- progresses upward → thoracic → cervical
- First finding:
  - Erosions of the corners
  - Secondary reactive sclerosis → “ivory” corners
  - Squared appearance
- Second finding:
  - Ossification; first outer portion; anulus fibrosus
    - Causing lack of motion in flexion and extension films
    - Later: extension into deep layers of longitudinal ligaments
      - Syndesmophyte formation
- Disc space:
  - Preserved before ankylosis
  - Calcification possible after ankylosis
Syndesmophyte formation
Ankylosing spondylitis: thoracic and lumbar vertebrae "squaring," osteopenia, and ossification
Ankylosing spondylitis: lumbar vertebrae, bamboo spine
BONY CHANGES IN VERTEBRAL COLUMN

- Normal
- Osteophytes
- Syndesmophytes
- Nonmarginal syndesmophytes

© www.rheumtext.com - Hochberg et al (eds)
Apophyseal joints

- May or may not be involved
- Ossification of ligaments of spinous processes possible
- Bamboo spine
  - Misdiagnosed complication:
    - Pseudarthrosis → lower thoracic-upper lumbar
      - Around the area of true fracture or
      - Area of skipped ossification
      - Single point of motion in the spine
      - Can undergo degenerative changes
characteristic “bamboo spine”
Coronal cut
MRI finding

- subchondral edema
- Bone Marrow edema
Early detection of sacroilitis on MRI

- **Objectives**
  - To investigate the diagnostic value of MRI in the detection of early sacroiliitis

- **Methods**
  - **Prospective longitudinal study**
    - 25 consecutive HLA-B27 positive patients
    - Inflammatory low back pain
    - <grade 2 unilateral sacroiliitis with conventional radiography
    - ESR and CRP followed for 3 years
    - Clinical assessment at entry and after 3 years
    - PR and MRI of SI joint at entry and after 3 years
    - PR and MRIs interpreted independently and randomly by 2 blind investigators
    - The MRI images were interpreted for BM edema as well

*J Rheumatol 1999; 26: 1953-8*
SI joint scoring: (modified New York Criteria)

- G1: suspicious
- G2: minimal abnormality with small erosions
- G3: definitive abnormality (erosion and sclerosis)
- G4: total ankylosis
Odds ratio with 95% CI used to examine relationship between:

- Inflammation (CRP>10, ESR>15, SI tenderness) and BM edema
- Signs of inflammation and >G2 sacroiliitis with MRI
- Presence of BM edema on MRI and >G2 sacroiliitis on MRI at entry
- Presence of edema on MRI at entry and >G2 sacroiliitis on PR after 3 years
- Presence of >G2 sacroiliitis on MRI at entry and >G3 sacroiliitis on PR after 3 years
Patient's data:

- Median age 36
- Median duration of ILBP 4 years
- 24 used NSAIDS
- 23 with alternating R and L buttock pain
- 2 had uveitis with positive FH of AS
- No reactive A. IBD, psoriasis hx
- At entry clinical findings and MRI suggested definitive AS in 16 patients, PR in 2 patients
- St entry 20 patients found to have subchondral edema
- 2 lost to F/U
### Relationship between signs of inflammation and BM edema on MRI at study entry

<table>
<thead>
<tr>
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<th>Odds Ratio</th>
<th>95% CI</th>
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<tr>
<td>CRP &gt; 10</td>
<td>2.08</td>
<td>0.3-10.94</td>
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<tr>
<td>ESR &gt; 15</td>
<td>2.09</td>
<td>0.36-12.32</td>
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<tr>
<td>SI tenderness</td>
<td>0.23</td>
<td>0.06-0.92</td>
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Relationship between signs of inflammation and G2 sacroiliitis on MRI at study entry

<table>
<thead>
<tr>
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<th>Odds Ratio</th>
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<tr>
<td>CRP &gt; 10</td>
<td>8</td>
<td>0.78-79.66</td>
</tr>
<tr>
<td>ESR &gt; 15</td>
<td>4.8</td>
<td>0.48-48.46</td>
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<tr>
<td>SI tenderness</td>
<td>1.2</td>
<td>0.30-4.79</td>
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Relationship between presence of BM edema on MRI at study entry and presence of >G2 sacroiliitis on MRI at entry and presence of >G2 sacroiliitis on PR after 3 years

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
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<tr>
<td>&gt;G2 Si-tis on MRI at entry</td>
<td>6</td>
<td>1.17-30.72</td>
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<tr>
<td>&gt;G2 Si-tis on PR after 3 yrs</td>
<td>2.7</td>
<td>0.72-10.05</td>
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Comparison of >G2 si-it is with MRI at entry and > G2 si-it is by PR after 3 yrs

(OR: 5.5; 95% CI: 1.26-23.94)

<table>
<thead>
<tr>
<th></th>
<th>&gt;G2 si-it is PR af. 3 yrs</th>
<th>&lt;G2 si-it is PR af. 3 yrs</th>
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<tbody>
<tr>
<td>&gt;G2 si-it is MRI entry</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>&lt;G2 si-it is MRI entry</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>23</td>
</tr>
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</table>
Result

- **At study entry:**
  - MRI detected >G2 spondylitis of 36 out of 50 SI joints without any PR evidence of spondylitis.
  - MRI + clinical findings suggested definitive Dx of AS in 16 patients.
  - PR detected 2 cases of unilateral >G3 spondylitis.

- **After 3 yrs:**
  - Definitive Dx of AS made in remaining 10/22 pts.
  - 8 of these had bilateral SI-iltis >G2 on MRI at entry.
Conclusion

- MRI can reveal definitive evidence of sacroiliitis in HLA-B27 + patients with ILBP at an earlier stage compared to plain X-ray.
Advantages:

- Prevention of progression of disease at early stages

Disadvantage:

- Very expensive
MRI of normal SI joint
Abnormal SI joint
By MRI (sacroiliitis)
Figure 1 Early sacroiliitis. (a) Coronal oblique STIR image and (b) axial T2W fast spin-echo images of the sacroiliac joints showing sacral bone marrow oedema parallel to the sacroiliac joints.
Figure 11 Costovertebral joint ankylosis. Axial T1W spin-echo MRI through the mid-thoracic region showing bilateral costovertebral joint ankylosis, manifest as obliteration of the joint space and continuous medullary bone across the joint.
Figure 12  Facet joint and neurocentral joint ankylosis. (a) Parasagittal T1W spin-echo MRI through the cervical spine demonstrates multilevel ankylosis of the facet joints. (b) Parasagittal T1W spin-echo MRI through the cervical vertebral bodies demonstrates multi-level ankylosis of the neurocentral joints of Luschka (arrows).
Figure 15  Atlanto-axial fusion. Sagittal T2W MRI of the cervical spine demonstrates spontaneous atlanto-axial fusion.
Figure 17  Thoracic fracture with cord compression. (a) Sagittal T1W spin-echo and (b) T2W fast spin-echo MRI through the lower thoracic region demonstrates a fracture through the subchondral region extending posteriorly through the ossified interspinous ligament. Compression of the cauda equina and tip of conus is evident.
Figure 5  Synodesmophytes. (a) Sagittal T1W spin-echo and (b) T2W fast spin-echo sequence of the lower thoracic and lumbar spine showing lower thoracic kyphosis and ossification of the anterior annulus resulting in vertebral body fusion from T7 to T10. Discovetebral lesions and hyperintense nuclear disc calcification are also noted in the lumbar region (arrows).
Ankylosing spondylitis: thoracolumbar spine, pseudarthrosis (CT scan)
Differential Diagnosis

- DISH
- Osteitis Condencecence
- Reactive arthritis
- SAPHO
- Psoriatic spondyloarthropathy
- IBD arthropathy
Do the radiological changes of classic ankylosing spondylitis differ from the changes found in the spondylitis associated with inflammatory bowel disease, psoriasis, and reactive arthritis?

*Ann Rheum Dis* 1998;57:135-140
<table>
<thead>
<tr>
<th></th>
<th>Ankylosing spondylitis</th>
<th>Enteropathic spondylitis</th>
<th>Psoriatic spondylitis</th>
<th>Reactive arthritis</th>
<th>$\chi^2$ (df=3)*</th>
<th>Significant†</th>
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<tr>
<td>Number</td>
<td>91</td>
<td>31</td>
<td>34</td>
<td>7</td>
<td></td>
<td></td>
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<tr>
<td>Male/female</td>
<td>67/24</td>
<td>15/16</td>
<td>26/8</td>
<td>7/0</td>
<td>11.24</td>
<td>NS</td>
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<tr>
<td>Age (y) median (range)</td>
<td>46 (18–71)</td>
<td>48 (34–75)</td>
<td>46 (25–83)</td>
<td>43 (25–47)</td>
<td>6.58</td>
<td>NS</td>
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<tr>
<td>Duration disease (y) median (range)</td>
<td>18 (1–44)</td>
<td>15 (6–39)</td>
<td>16 (0–56)</td>
<td>8 (5–12)</td>
<td>7.15</td>
<td>NS</td>
</tr>
<tr>
<td>Number (%) heel involvement</td>
<td>12/82 (15)</td>
<td>3/17 (18)</td>
<td>4/21 (20)</td>
<td>1/4 (25)</td>
<td>††</td>
<td></td>
</tr>
<tr>
<td>Number (%) uveitis</td>
<td>19/83 (23)</td>
<td>14/21 (67)</td>
<td>4/23 (18)</td>
<td>1/5 (20)</td>
<td>17.75</td>
<td>0.004</td>
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<tr>
<td>Schöber's (cm) median (range)</td>
<td>2 (0–7)</td>
<td>4 (0–7)</td>
<td>4.85 (1–8)</td>
<td>5.5 (4–7.5)</td>
<td>15.3</td>
<td>0.016</td>
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<tr>
<td>Chest expansion (cm) median (range)</td>
<td>3 (0–6.5)</td>
<td>4 (0–6)</td>
<td>4 (0–6)</td>
<td>3 (0–6)</td>
<td>1.36</td>
<td>NS</td>
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<tr>
<td>Number (%), B27 positive</td>
<td>31/37 (84)</td>
<td>8/10 (80)</td>
<td>4/6 (67)</td>
<td>2/2 (100)</td>
<td>††</td>
<td></td>
</tr>
</tbody>
</table>

* $\chi^2$ on 2×4 tables, Kruskal-Wallis analysis of variance, $\chi^2$ statistic for interval scale data. †† Values multiplied by 8 to allow for multiple comparisons. †Comparison not made because minimum expected frequency in two cells was <2.
<table>
<thead>
<tr>
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<th>Psoriatic spondylitis</th>
<th>Reactive arthritis</th>
</tr>
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<tbody>
<tr>
<td>Number of films available (no of cases)</td>
<td>91/91</td>
<td>31/31</td>
<td>34/34</td>
<td>7/7</td>
</tr>
<tr>
<td>Worst SI grade (number (%)) grades 3–4</td>
<td>84 (92)</td>
<td>30 (97)</td>
<td>28 (82)</td>
<td>7 (100)</td>
</tr>
<tr>
<td>Symmetry (number (%))</td>
<td>77 (85)</td>
<td>31 (100)</td>
<td>25 (74)</td>
<td>3 (43)</td>
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<tr>
<td>Symphysis (number (%)) grades 3–4</td>
<td>27 (31)</td>
<td>9 (30)</td>
<td>8 (25)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Iliac enthesis (number (%)) grades 3–4</td>
<td>6 (7)</td>
<td>1 (4)</td>
<td>1 (4)</td>
<td>0</td>
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<tr>
<td>Ischial enthesis (number (%)) grades 3–4</td>
<td>25 (30)</td>
<td>4 (14)</td>
<td>6 (22)</td>
<td>0</td>
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<tr>
<td>Hip involvement (number (%)) grades 3–4</td>
<td>22 (26)</td>
<td>4 (14)</td>
<td>7 (23)</td>
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<tr>
<td>Number of films available (no of cases)</td>
<td>Ankylosing spondylitis</td>
<td>Enteropathic spondylitis</td>
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<td>Reactive arthritis</td>
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<tr>
<td>----------------------------------------</td>
<td>------------------------</td>
<td>--------------------------</td>
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<td>--------------------</td>
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<tr>
<td>Number (%) symmetry*</td>
<td>43 (55)</td>
<td>38/52 (73)</td>
<td>1 (1)</td>
<td>12/52 (23)</td>
</tr>
<tr>
<td>Paravertebral ossification (number %)</td>
<td>1 (1)</td>
<td>1 (4)</td>
<td>1 (4)</td>
<td>5/16 (31)</td>
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<tr>
<td>Chunky syndesmophytes (number %)*</td>
<td>10 (40)</td>
<td>8/16 (50)</td>
<td>1 (4)</td>
<td>3/16 (19)</td>
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<tr>
<td>Ligamentous calcification (number %)</td>
<td>11 (14)</td>
<td>1 (4)</td>
<td>1 (4)</td>
<td>11 (14)</td>
</tr>
<tr>
<td>Squaring (number %)</td>
<td>15 (19)</td>
<td>1 (4)</td>
<td>1 (4)</td>
<td>1 (4)</td>
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<tr>
<td>Romanus lesion (number %)</td>
<td>17 (22)</td>
<td>0</td>
<td>4 (14)</td>
<td>17 (22)</td>
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<tr>
<td>Spinal pseudarthrosis (number %)</td>
<td>2 (3)</td>
<td>0</td>
<td>1 (4)</td>
<td>2 (3)</td>
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<tr>
<td>Zygopophyseal ankylosis (number %)</td>
<td>16 (21)</td>
<td>4 (16)</td>
<td>0 (0)</td>
<td>16 (21)</td>
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<tr>
<td>Discitis (number %)</td>
<td>5 (6)</td>
<td>2 (8)</td>
<td>1 (4)</td>
<td>5 (6)</td>
</tr>
<tr>
<td>Bamboo spine (number %)</td>
<td>9 (12)</td>
<td>3 (12)</td>
<td>0 (0)</td>
<td>9 (12)</td>
</tr>
</tbody>
</table>

*Note data on symmetry and syndesmophyte morphology only apply to severity grades 2–4: the number of available films is given by the denominator.
<table>
<thead>
<tr>
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<td>Number of films available (no of cases)</td>
<td>64/91</td>
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<td>14/34</td>
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<tr>
<td>Worst grade (number (%)) grades 3–4</td>
<td>29 (45)</td>
<td>4 (31)</td>
<td>5 (36)</td>
<td>1 (25)</td>
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<tr>
<td>Number (%) symmetry*</td>
<td>24/40 (60)</td>
<td>4/5 (80)</td>
<td>2/6 (33)</td>
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<td>Paravertebral ossification (number (%))</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>Chunky syndesmophytes (number (%))*</td>
<td>2/40 (5)</td>
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<td>4/6 (67)</td>
<td>1/2 (50)</td>
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<tr>
<td>Ligamentous calcification (number (%))</td>
<td>9 (14)</td>
<td>0</td>
<td>2 (14)</td>
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<tr>
<td>Squaring (number (%))</td>
<td>7 (11)</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>Romanus lesions (number (%))</td>
<td>9 (14)</td>
<td>0</td>
<td>2 (14)</td>
<td>1 (25)</td>
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<tr>
<td>Spinal pseudarthrosis (number (%))</td>
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<td>Zygapophyseal ankylosis (number (%))</td>
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<td>Discitis (number (%))</td>
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<tr>
<td>Baraboo spine (number (%))</td>
<td>8 (13)</td>
<td>2 (15)</td>
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*Note data on symmetry and syndesmophyte morphology only apply to severity grades 2–4; the number of available films is given by the denominator.
### Table 6  Cervical spine involvement

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<tr>
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<td>5 (45)</td>
<td>9 (47)</td>
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<tr>
<td>Number (%) symmetry†</td>
<td>19/19 (100)</td>
<td>2/4 (50)</td>
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<tr>
<td>Paravertebral ossification (number (%))</td>
<td>1 (2)</td>
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<td>2 (11)</td>
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<tr>
<td>Chunky syndesmophytes (number (%))</td>
<td>3/34 (9)</td>
<td>1/6 (17)</td>
<td>5/12 (42)</td>
<td>1/1 (100)</td>
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<tr>
<td>Ligamentous calcification (number (%))</td>
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<td>Squaring (number (%))</td>
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<tr>
<td>Romanus lesions (number (%))</td>
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<tr>
<td>Spinal pseudarthrosis (number (%))</td>
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<td>1 (9)</td>
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<td>0</td>
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<tr>
<td>Zygopophyseal ankylosis (number (%))</td>
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<td>2 (11)</td>
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</tr>
<tr>
<td>Discitis (number (%))</td>
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<td>1 (9)</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Bamboo spine (number (%))</td>
<td>5 (9)</td>
<td>0</td>
<td>1 (5)</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note data on symmetry and syndesmophyte morphology only apply to severity grades 2–4: the number of available films is given by the denominator. †It was not possible to evaluate cervical symmetry in 23 cases because syndesmophytes were only seen on lateral radiographs.
Reactive arthritis: sacroiliitis
Osteitis condensans ilii: pelvis
Diffuse idiopathic skeletal hyperostosis
SAPHO
MRI
Conclusion

- The role of MRI in imaging of AS has greatly expanded
- With MRI the disease can be detected much earlier → early treatment → early prevention of disability
- When high suspicion → do not delay MRI imaging