Back Pain in Primary Care

• Back pain is a common presenting problem in general practice.
  – most due to mechanical dysfunction.
  – serious causes are rare (1% of cases).

• Traditional teaching:
  – specific cause of pain need not be established.
  – exclude serious cause by taking a history looking for ‘red flags’.
  – imaging not required.
Why was imaging not required?

- Most symptoms occur in axially loaded positions such as sitting and standing.
- Traditional static/unloaded spine imaging (e.g. CT, MRI) does not provide an understanding of the physiological changes seen with weight bearing.
- New imaging modalities (e.g. EOS) may help understand this relationship.
EOS

- Is not an acronym like CT or MRI.
- Name of French Company (Formally Biospace Med) that developed technology.
How does EOS work?

- Simultaneous AP and lateral 2D images of the whole body.
- 3D reconstructions performed based on statistical models.
EOS
EOS vs Radiography

- Larger coverage (175cm vs 90cm).
- No stitching artefact.
- No geometric magnification due to divergent beam.
- Precise measurements.
- Reduced radiation dose (xenon multiwire proportional chamber).
### Radiation exposure: How does it compare?

Exposure measured in mSv

<table>
<thead>
<tr>
<th>Exposure Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000</td>
<td>Fatal within weeks</td>
</tr>
<tr>
<td>6,000</td>
<td>Typical dosage recorded in those Chernobyl workers who died within a month</td>
</tr>
<tr>
<td>5,000</td>
<td>Single dose which would kill half of those exposed to it within a month</td>
</tr>
<tr>
<td>1,000</td>
<td>Single dose which could cause radiation sickness, nausea, but not death</td>
</tr>
<tr>
<td>400</td>
<td>Max radiation levels recorded at Fukushima plant 14 March, per hour</td>
</tr>
<tr>
<td>350</td>
<td>Exposure of Chernobyl residents who were relocated</td>
</tr>
<tr>
<td>100</td>
<td>Recommended limit for radiation workers every five years</td>
</tr>
<tr>
<td>10</td>
<td>Dose in full-body CT scan</td>
</tr>
<tr>
<td>9</td>
<td>Airline crew NYC - Tokyo polar route, annual</td>
</tr>
<tr>
<td>2</td>
<td>Natural radiation we're all exposed to, per year</td>
</tr>
<tr>
<td>1.02</td>
<td>Radiation per hour detected Fukushima site, 12 March</td>
</tr>
<tr>
<td>0.4</td>
<td>Mammogram breast x-ray</td>
</tr>
<tr>
<td>0.1</td>
<td>Chest x-ray</td>
</tr>
<tr>
<td>0.01</td>
<td>Dental x-ray</td>
</tr>
</tbody>
</table>

**SOURCE:** WNN, RADIOLGYINFO.ORG, REUTERS
Indications for EOS Imaging:

- Range of applications growing rapidly.
- Paediatric applications.
- Mostly:
  - Assessment and follow-up of balance disorders.
    - Spinal assessment.
    - Lower limb assessment.
  - Advanced orthopaedic assessment (e.g. rotational profiles).
Spinal Assessment

- Complex dynamic structure.
- Normally balanced spine has C7 positioned over S1 in both coronal and sagittal planes.
- Imbalanced spine may be source of pain.
Coronal Balance

- C7 plumb line is line drawn inferiorly from centre of C7 vertebral body.
- CSL (central sacral line) is line drawn up from centre of sacrum.
- C7-CSL distance >4cm – studies have shown correlation to poor function and increased pain = coronal imbalance.
Coronal Balance

![Coronal X-ray image with annotations and diagram showing spine parameters and Cobb angle calculation.](image)
Sagittal Balance

- SVA (sagittal vertical axis) = distance between C7 plumb line and superoposterior corner of S1.
- SVA line distance >4cm – studies have shown correlation to poor function and increased pain = sagittal imbalance.
Sagittal Balance
Lower limb assessment

- Measures:
  - Leg lengths.
  - Femoral/tibial lengths.
  - Varus/valgus at the knee joint.

- Results in pelvic obliquity, causing functional spinal scoliosis.
Lower limb assessment
Pelvic Parameters

- Pelvic obliquity = due to leg length discrepancy/compensation of coronal imbalance.
- Pelvic incidence = fixed value. Forms basis for calculating optimal degree of lumbar lordosis required post-operatively to maintain normal balance (+/- 10 degrees).
- Pelvic tilt = degree of compensatory retroversion of pelvis due to sagittal imbalance.
- Sacral slope.
**Pelvic Parameters**

<table>
<thead>
<tr>
<th>Pelvic parameters</th>
<th>Measured</th>
<th>Theoretic (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvic incidence</td>
<td>55°</td>
<td>-</td>
</tr>
<tr>
<td>Sacral slope</td>
<td>33°</td>
<td>43°</td>
</tr>
<tr>
<td>Pelvic tilt</td>
<td>22°</td>
<td>12°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sagittal balance</th>
<th>Measured</th>
<th>Theoretic (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lordosis T12/S1</td>
<td>45°</td>
<td>68° (3)</td>
</tr>
<tr>
<td>Kyphosis T1/T11</td>
<td>42°</td>
<td>-</td>
</tr>
<tr>
<td>Knee extension</td>
<td>2°</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Global alignment</th>
<th>Measured</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SVA</td>
<td>11 mm</td>
<td></td>
</tr>
</tbody>
</table>

Synthesis: Balanced with a compensatory mechanism by pelvic retroversion.

Reference values are defined for the adult asymptomatic Caucasian population (age > 18 years). These values are not valid for the patients having a vertebrae specialization.

1. Malek-Pirhong et al. (Eur Spine J 2001)
3. Maximal Lumbar Lordosis
Others e.g. rotational profile

- 3D EOS equivalent to CT.
- Available on specific request.
- Up to 1 week turn around.
Management – Conversative vs Surgical
References