Sagittal Plane Deformity

Evaluation and Management of Sagittal Plane Deformity

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Disclosures

• Research/Institutional Support:
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• Ownership/Stock/Options:
  Providence Medical, Simpirica
• Royalties:
  – Medtronic

Sagittal Malalignment

• Clinical Presentation
  – Imbalance
  – Difficulty with horizontal gaze
  – Early fatigue
  – Intractable pain
Causes of Sagittal Malalignment

- Congenital anomaly
- Ankylosing spondylitis
- Iatrogenic:
  - Flatback Syndrome
  - Kyphotic Decompensation Syndrome
  - Adjacent segment pathology
- Post-traumatic
- Infectious
- Neoplastic
- Osteoporotic Compression Fractures
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Clinical and Radiographic Evaluation
Localization of Deformity
Pelvic-femoral axis

- Extraspinal
  - Pelvic-femoral axis
• Different arm positions
• Knee Flexion
• Straight Line Walking

Reflections of an Orthopaedic Surgeon on Patient Care and Research Into the Condition of Scoliosis

• Cone of Economy
• Minimum muscular energy is required to maintain balance between the heavy cephalic vertebrae (the head) and the polygon of support (both feet).
Sagittal Balance
Cone of economy

- Muscle demand
- Fatigue
- Pain/Disability
- Loss of forward gaze
- Loss of head over pelvis

Jean Dubousset
For a right triangle:
\[
\text{opp} / \text{adj} = \tan \\
\tan \theta = \text{angle in degrees}
\]

\[
9/33 = 0.27 \\
\tan^{-1}(0.27) = 15^\circ
\]
Pelvic incidence: a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves

- The pelvic incidence is the primary determinant of the sagittal balance of the spine
- Chain of interdependence between the pelvic incidence and other spinal parameters

J. Legaye
G. Duval-Beaupère
J. Hocquet
C. Marty

A Clinical Impact Classification of Scoliosis in the Adult

Frank Schriewel, M.D.,* Jean Fano Perny, M.D.,* Keith Birkett, M.D.,† Sigrid Boren, M.D.,‡
Scott Runyan, M.D.,§ John Hamel, M.D.,∥ and William Hutton, M.P.T.

• Radiographic classification system based upon factors associated with change in HRQoL.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Radiographic Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Thoracic-only curve in other curves</td>
</tr>
<tr>
<td>II</td>
<td>Upper thoracic major, apex T4–T5</td>
</tr>
<tr>
<td>III</td>
<td>Lower thoracic major, apex T9–T12</td>
</tr>
<tr>
<td>IV</td>
<td>Lumbosacral major curve, apex L1–L4</td>
</tr>
<tr>
<td>V</td>
<td>Lumbosacral major curve, apex L4–L5</td>
</tr>
<tr>
<td>Lumber lordosis modifier</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Marked lordosis (≥40°)</td>
</tr>
<tr>
<td>B</td>
<td>Moderate lordosis (30°–40°)</td>
</tr>
<tr>
<td>C</td>
<td>No lordosis present (≤20°)</td>
</tr>
<tr>
<td>Subtype modifier</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>No intervertebral subsidence any level</td>
</tr>
<tr>
<td>+</td>
<td>Minimal measured subsidence 1–5 mm</td>
</tr>
<tr>
<td>++</td>
<td>Minimal subsidence &gt;7 mm</td>
</tr>
</tbody>
</table>

Scoliosis Research Society—Schwab Adult Spinal Deformity Classification

A Validation Study

Frank Schriewel, M.D.,* Benjamin Unger, M.D.,† Benjamin Rundell, M.D.,‡ Jacob Bucharowski, M.D.,¶
Joseph D. Call, M.D.,§ Douglas D’Amore, M.D.,∥ Christopher Detemple, M.D.,¶ Thomas Harnick, M.D.,∥
Christopher Cheshire, M.D.,§ Clifford Selby, M.D.,∥ and Douglas Lange, M.D.,∥

Coronal Curve Types

- Thoracic-only without curve ≥10°
- L forged without curve ≥10°
- Double Curve with ≥10° main curve ≥10°
- No Major Coronal Deformity defined as ≤10°
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Diagram</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Resection of posterior elements from mid pars above to pedicle below with realignment of the spine through hinging through a mobile disc anteriorly</td>
<td>Ponte</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Resection of posterior elements from mid pars above to pedicle below with realignment of the spine through hinging through a mobile disc anteriorly</td>
<td>Smith-Peterson</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Posterior-based transpedicular decancellation of the vertebral body with realignment through controlled fracture of the anterior column</td>
<td>Heinig</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Posterior-based intraosseous wedge resection of the vertebral body with realignment through osteoclasis of the proximal third of the anterior vertebral body</td>
<td>Thomasen</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Posterior-based wedge resection with excision of the remaining into the space adjacent to the endplate and realignment hinging on the anterior column at the intervertebral space</td>
<td>Modified Thomasen</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Posterior-based vertebral column resection including one or more vertebrae with adjacent discs</td>
<td>Suk</td>
<td></td>
</tr>
<tr>
<td>Measurement</td>
<td>Pre-op</td>
<td>Post-op</td>
<td>Change</td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>SVA</td>
<td>125</td>
<td>40</td>
<td>85</td>
</tr>
<tr>
<td>LL: L1-S1</td>
<td>50</td>
<td>78</td>
<td>28</td>
</tr>
<tr>
<td>TK: T5-12</td>
<td>30</td>
<td>36</td>
<td>6</td>
</tr>
<tr>
<td>L5-S1</td>
<td>-6</td>
<td>-6</td>
<td>0</td>
</tr>
<tr>
<td>L3 slip Neut</td>
<td>12/40 (30%)</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>L3 slip Flex</td>
<td>14/40 (35%)</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>L3 slip Ext</td>
<td>12/40 (30%)</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>L3-4</td>
<td>14</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>PI</td>
<td>86</td>
<td>86</td>
<td>0</td>
</tr>
<tr>
<td>PT</td>
<td>34</td>
<td>20</td>
<td>-14</td>
</tr>
<tr>
<td>SS</td>
<td>53</td>
<td>67</td>
<td>14</td>
</tr>
<tr>
<td>PI - LL</td>
<td>36</td>
<td>8</td>
<td>28</td>
</tr>
</tbody>
</table>
Chain of Balance

Interrelationship between regions of the spine in which the role of the pelvic vertebra is to adopt a posture that conserves muscular energy.

Lumbopelvic Parameters

Chain of Correlation between lumbopelvic alignment and health-related quality of life.

Chain of Correlation

Pelvic Incidence: LL as TIA: CL

Thoracic inlet angle = T1 slope + Neck tilt

Pelvic Incidence: LL as TIA: CL
Conclusions

• Sagittal deformity has an important and measurable impact on Health-related Quality of Life
• Clinical and Radiographic Assessment (36° films) with patient standing upright are important to identify sagittal deformity
• Measurement of Pelvic parameters are important for accurate assessment of deformity
• Most of Lumbar Lordosis is between L4-S1
• Restoration of Sagittal imbalance may require:
  – Anterior column reconstruction L4-S1
  – Significant resection of posterior elements with posterior osteotomies
• Goals for sagittal deformity correction are:
  – Segmental Lordosis
  – SVA<5cm
  – Match PI and LL
  – PT<20 degrees