Flatback Syndrome

Pathologic Loss of Lumbar Lordosis

Robert P. Norton, MD
Florida Spine Specialists
Orthopaedic Spine Surgery
Clinical Associate Professor, FAU College of Medicine
Boca Raton, FL
Sagittal Plane Analysis

Courtesy of F. J. Schwab, MD
Why is Alignment Important?

Poor alignment = disability

- Must compensate for anatomic deformity
- Mechanical disadvantage challenges balance mechanisms

Deviation from stable zone = Increased muscular energy use

Jean Dubousset
“Normal” Sagittal Alignment

**Classification of the Normal Variation in the Sagittal Alignment of the Human Lumbar Spine and Pelvis in the Standing Position**

Pierre Roussouly, MD,* Sohrab Gollogly, MD,* Eric Berthonnaud, PhD,† and Johannes Dimnet, PhD†

- **Large PI**
  - Large Sacral Slope
  - Marked, long lordosis
- **Small PI**
  - Small Sacral Slope
  - Flat Lordosis
Radiographic Regional Alignment

Fon, Stagnara, Benhardt, Jackson, Gelb, Vialle,…

Thoracic kyphosis  20-40
Lumbar Lordosis    30-80

Curves ‘Proportional’ to One Another
Radiographic **Global** Alignment

**Distance**
- C7 Plumbline – Posterior Superior Corner of Sacrum

**Angle**
- Vertical vs line between femoral heads and T1

- SVA 0-5cm
- T1 SPI <0°
Radiographic Spino-pelvic Alignment

Spino-pelvic parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvic Incidence</td>
<td>40° - 65°</td>
</tr>
<tr>
<td>Pelvic Tilt</td>
<td>10° - 25°</td>
</tr>
<tr>
<td>Sacral Slope</td>
<td>30° - 50°</td>
</tr>
<tr>
<td>Lumbar Lordosis</td>
<td>40° - 80°</td>
</tr>
<tr>
<td>Thoracic Kyphosis</td>
<td>20° - 40°</td>
</tr>
</tbody>
</table>
Sagittal parameters are correlated with Health related Quality of Life scores (HRQOL)

Pl minus LL

• **#1** most important parameter

• **Correlation with**
  - SRS (appearance, activity, total)
  - ODI (Walk, stand)
  - SF12 (PCS)

**GOAL:** LL = PI +/- 9°

Pl – LL measures the harmony between lordosis and the shape of the pelvis (Pelvic incidence)
Two patients: same LL, different PI
SVA and T1-SPI

- **Second** most important parameter

- **Correlation with**
  - SRS (appearance, activity, total)
  - ODI
  - SF12 (PCS)

- T1-SPI had greater correlation with HRQOL compared to SVA.
Pelvic Tilt

- **Third** most important parameter
- Correlation with HRQOL
  - SRS (appearance, activity, total)
  - ODI (Walk, stand)
  - SF12 (PCS)
Impact of pelvic rotation on SVA

Standing position

Extreme Pelvic Retroversion

Extreme Pelvic Anteversion
3 most highly correlated parameters

1. PI minus LL
2. SVA
3. Pelvic Tilt

Among all Coronal and Sagittal Parameters
Operative and Non-Operative Patients pre and post-op
Thresholds for Disability

- **Multi-linear models**
  - \( \text{ODI} = 0.2106 \times \text{PT} + 13.719 \)
  - \( \text{ODI} = 1.5563 \times \text{SVA} - 16.293 \)
  - \( \text{ODI} = 0.4379 \times \text{PI-LL} - 6.0827 \)

- **Thresholds for Disability**
  - \( \text{(ODI}>40) \)
    - PI – LL > 11 °
    - SVA > 47mm
    - PT > 22°

- **Global alignment**
  - \( \text{PI minus LL} \)
    - 0 : within 10°
    - + : moderate 10-20°
    - ++ : marked >20°

- **Pelvic Tilt**
  - 0 : PT<20°
  - + : PT 20-30°
  - ++ : PT>30°
Realignment: not simple math

**Trigonometric formula**

PSO angle = $\text{atan} \left( \frac{y}{z} \right)$

Ondra et al
Neurosurgery, 2006

No consideration of Pelvic parameters!
Clinical relevance of PT

Schwab, Lafage, ISSG [IMAST 2009]

**Group 1**
Large SVA
No PT

**Group 2**
Large SVA
Large PT

Satisfactory Post-op SVA

1. Larger PT (Group 2) require larger PSO resections
2. SVA not enough to plan surgery
3. Pre Op PT must be considered
Ex: PSO on large SVA / low PT

- **Pre-Op Evaluation**
  - Large SVA (>20cm)
  - No Pelvic Retroversion

- **PSO Planning**
  - SVA correction
  - $\Delta \text{LL} = 28\text{deg}$

- **Post-Op Evaluation**
  - SVA <5cm
  - No Pelvic Retroversion
Ex: PSO on large SVA / Large PT

Pre-Op Evaluation
Large SVA (>20cm)
Large PT (38 deg)

PSO Planning
SVA + PT correction
Δ LL = 46deg

Post-Op Evaluation
SVA <5cm
PT < 25deg
Driver versus Compensation

- Adult Spinal Deformity driver:
  - Loss of lumbar lordosis
  - Quantified by spino-pelvic mismatch:
    - PI-LL, *Schwab et al 2010*.\(^5\)

- Compensatory Mechanisms established:
  - Pelvic retroversion
    - *Duval-Beaupere et al* \(^6\)
  - Knee flexion
    - *Itoi*, *Obeid et al* \(^8\)
  - Pelvic Shift (translation)
    - *Schwab et al* \(^9\)
  - Thoracic Flattening ….

Is this non-sense applicable to your individual practice?
Definition of Flatback Syndrome

Fixed sagittal plane deformity with loss of lumbar lordosis or an actual lumbar kyphosis.
Causes

- Short or long segment lumbar fusions without restoration of lumbar lordosis.
- Inadequate anterior column support, when indicated.
- Scoliosis progression.
- Degenerative disc disease below a long fusion, particularly at the lumbosacral spine.
- Postlaminectomy deformity.
- Harrington posterior distraction instrumentation.
- Pseudoarthrosis.
- Fractures about or below a long fusion.
- Ankylosing spondylitis.
Clinical presentation

- Inability to stand upright.
- Worsening pain and fatigue with increased activities.
- Some cases with neurologic deficit.
The “obvious” Deformity

- Key radiographic parameters:
  - Loss of LL versus PI (PI-LL)
  - Pelvic Retroversion (PT)
  - Global Malalignment (SVA, TPA, ...)
  - Thoraco-Lumbar Kyphosis (TL)
  - Rotatory Subluxation
Treatment:
What works, how are we doing?
Non Operative care: does it work?

Glassman 2010:
68 non-op patients, 55 no treatment patients

Exercise therapy, physical therapy, narcotic and non-narcotic medication, injections/blocks, chiropractic treatment

Combined non-op vs. no treatment

No Difference!

| Table 2. Summary of Baseline and 2 Year Post-Treatment Outcome Scores Between Patients Who Received and Did Not Receive Treatment |
| Mean Score | No Treatment | Treatment |
| Baseline | 2-yr | P | Baseline | 2-yr | P |
| SRS activity | 3.7 | 3.7 | 0.303 | 3.4 | 3.3 | 0.097 |
| SRS pain | 3.7 | 3.7 | 0.843 | 3.1 | 3.0 | 0.232 |
| SRS appearance | 3.5 | 3.5 | 0.557 | 3.1 | 3.0 | 0.890 |
| SRS satisfaction | 3.7 | 4.0 | 0.014 | 3.3 | 3.4 | 0.486 |
| SRS total | 3.6 | 3.7 | 0.221 | 3.3 | 3.3 | 0.405 |
| SF-36 MCS | 52.4 | 52.3 | 0.979 | 50.6 | 50.2 | 0.787 |
| SF-36 PCS | 46.3 | 48.6 | 0.097 | 35.8 | 34.7 | 0.311 |
| ODI | 20.1 | 19.6 | 0.742 | 30.8 | 32.7 | 0.164 |

Risk-Benefit Assessment of Surgery for Adult Scoliosis

An Analysis Based on Patient Age

Justin S. Smith, MD, PhD,*† Christopher I. Shaffrey, MD,*† Steven D. Glassman, MD,† Sigurd H. Berven, MD,§ Frank J. Schwab, MD,¶ Christopher L. Hamill, MD,|| William C. Horton, MD,** Stephen L. Ondra, MD,⇑ Charles A. Sansur, MD,+++ and Keith H. Bridwell, MD, §§ the Spinal Deformity Study Group
Success in treatment of ASD

- Operative Treatment leads to significant HRQOL improvement at 2yrs
- Outcome can be predicted in terms of significant (MCID) improvement

Surgical Treatment Seems to be Effective Overall...
Surgical Treatment

Anterior approaches:

• ALIF, XLIF with Lordotic or Hyperlordotic cages.

Posterior approaches:

• Smith-Petersen osteotomy.

• Pedicle subtraction osteotomy.

• Vertebral column resection.
Surgical Treatment
Smith-Petersen Osteotomy
Pedicle Subtraction Osteotomy
Vertebral Column Resection
Perioperative Complications Following Spinal Deformity Surgery
Significantly associated with death within 2 years

PERIOPERATIVE MEDICAL COMPLICATIONS

52.58%

CARDIAC 8.4%

RESPIRATORY 13%

NEURO 7.35%

UROLOGICAL 9.2%

HEMATOLOGICAL 10.75%

GASTROINTESTINAL 3.9%
Surgical Complications

Complications and intercenter variability of three-column osteotomies for spinal deformity surgery: a retrospective review of 423 patients

Kristina Bianco, B.A., Robert Norton, M.D., Frank Schwab, M.D., Justin S. Smith, M.D., Ph.D., Eric Klineberg, M.D., Ibrahim Obeid, M.D., Gregory Mundis Jr., M.D., Christopher I. Shaffrey, M.D., Khaled Kebsah, M.D., Richard Hostin, M.D., Robert Hart, M.D., Munish C. Gupta, M.D., Douglas Burton, M.D., Christopher Ames, M.D., Oheneba Boachie-Adjei, M.D., Themistocles S. Protopsaltis, M.D., and Virginie Lafage, Ph.D., on behalf of the International Spine Study Group

Major IOC: 7% (28% if include MBL >4L)
Major POC: 39%
Overall: 42%
Surgical Tips
To avoid Flatback
Realignment Planning
Realignment Planning
Realignement Planning
Patient Positioning

Avoid instrumention and fusion in the decompression position.
Patient Positioning

OSI – Jackson table for access and imaging
Hips in extension, maximize lordosis and facilitate osteotomy closure
Operative considerations

- SSEP, MEP, EMG monitoring
- EBL anticipation
- OR time: multiple surgeon

- Osteotomy techniques
Fusion Techniques

Instrumentation: avoid distraction or pseudo-distraction.
Intra-op radiographs

Stabilizing rod
Technical Execution - Surgery

- Extension of laminectomy
  - proximally/distally
  - Undercutting of edges

- Controlled closure
  - avoid dural pinch
Case Example 1

- 55 y/o woman with 14 prior spine surgeries
- Decline in quality of life, back pain, back fatigue and worsening deformity
- Takes Neurontin, Norco, Advil for pain
Operative Plan

- T4-Sacrum revision PSF
- Removal of old hardware
- Bilateral iliac screws
- Multiple SPO
Scoliosis - Adult
Case Example 2

- 62 y/o female
- Complains of worsening back pain, fatigue and posture
- Decline in quality of life, difficulty ambulating
- History of multiple prior spine surgeries
Operative Plan

- T10-Pelvis fusion
- Laminectomy L2-3, L3-4
- Pedicle Subtraction Osteotomy L3
- TLIF L2-3
- Iliac screws
Thank You