Sagittal Balance
Radiographic Assessment
And
Surgical Goals
Steven J. Tresser, MD

Disclosures
- Nuvasive – consultant, royalties, speaking
- K2M – consultant, royalties
- Centinel Spine – consultant, speaking
- CTL Medical – advisory board

Number of Articles Published on Sagittal Balance/Alignment by Year
Sagittal Balance

- How do we determine/measure it
- Why should we care about it?
- Defining surgical goals
- History of the problem and thought development
- How to plan surgeries using this information
- Future directions

The Spinopelvic Parameters

1. Lumbar Lordosis (LL)
2. Pelvic Incidence (PI)
3. Pelvic Tilt (PT)
4. Sagittal Vertical Axis (SVA)

Lumbar Lordosis

- L1-S1 angle
- Normal lumbar lordosis is within the range of $63^\circ \pm 15^\circ$
- Relates to pelvic incidence
  - Normal $PI - LL = +/- 9^\circ$
- At least 2/3 of LL is at L4-S1
Pelvic Incidence

- Angle between the perpendicular to mid-sacral endplate and femoral heads
- PI determines relationship to rest of spine
- Everyone’s pelvis is different
- Stays constant throughout adult life
- Not affected by patient position
- Rocking your pelvis backwards doesn’t change it

So What is The PI/LL Connection?

Normal Sagittal Alignment

Pelvic Incidence and Lordosis

- Large PI
  - Horizontal sacrum
  - Marked, long lordosis
- Small PI
  - Vertical sacrum
  - Flat lordosis
Pelvic Tilt

- Angle between the vertical and line drawn from mid-sacral endplate to femoral heads
- Normal pelvic tilt is **less than 20 degrees**
- Compensatory mechanism to reduce positive balance

Compensation and Pelvic Tilt

- Large SVA, No PT
- Moderate SVA / PT
- No SVA, Large PT

Large Pelvic Tilt => Hip Hyper-extension
Compromises Walking

SVA/TiSP
T1 Pelvic Angle
A New Predictor for Postoperative Sagittal Balance and Clinical Outcomes in Adult Scoliosis
Jun Qiao, MD; Feng Zhu, MD; Lurui Xu, MD; Zhen Lin, MD; Zhiqiang Zhu, MD; Hongying Qian, MD; Xu San, MD, and Yong Qu, MD
SPINE Volume 39, Number 25, pp 2103-2107

- Angle from T1 to femoral head to mid-sacral endplate
- Combines information from SVA or T1-SP and PT
- Angular measurement like T1-SP
- Immune to patient posture
- Better correlation with HRQOL than SVA

Need for good Radiographs

- Regional/focal x-rays can be misleading
- Long films without pelvis do not permit assessment of compensatory mechanisms
- Films including lower limbs are even better!

At a minimum

- Lumbar radiographs that include the femoral heads
  - Able to derive a PI, LL, and PT
  - Allows awareness of 'at risk' patients
The Spinopelvic Parameters

So….

How can we use all this to help our patients?

Thresholds for Disability (ODI>40)

- PI – LL > 11°
- SVA > 47mm
- PT > 20°

Global alignment

0: SVA < 4cm
+ : SVA 4 to 9.5cm
++ : SVA > 9.5cm

Pelvic Tilt

0: PT<20°
+ : PT 20-30°
++ : PT>30°

Impact of Sagittal Balance

- Adverse health outcomes are highly correlated with positive sagittal balance
- Sagittal balance assessment should be a critical consideration during patient evaluation and surgical planning
Alignment Matters

• Preservation/restoration of lumbar lordosis is crucial to the success (clinical outcome: pain/disability) of any lumbar fusion.

• Sagittal balance is directly correlated to clinical outcome: avoid sagittal decompensation.1,2

• If the clinically relevant radiographic parameters are not achieved the patient runs a 10x higher risk of reoperation.2


Goals for Patient Outcomes

Sagittal Balance Restoration aims to Improve patient quality of life:
• Resolve Pain and dysfunction
• Restore horizontal gaze
• Provide energy conservation
• Movement requires less muscle engagement and fatigue
• Restore “Cone of Economy”
• Arrest evolution of deformity


Goals for Sagittal Balance

Alignment Objectives1
1. PI – LL < 10°
2. PT < 20°
3. SVA < 5cm
Other Considerations

- Cervical sagittal balance
- The role of TK in complete global alignment
  - Effect on T1 slope
  - Effect on degree to which spinopelvic parameter correction will succeed
- Is LL = PI +/- 9 too much leeway?
- Age related correction adjustments

Thank you

How Can We Use This to Plan?

- Pre-operative planning
  - Identify if sagittal balance needs to be addressed
  - Identify/quantify the extent of problem
  - Plan/simulate cages and osteotomies
- Intra-operative assessment
- Inter-stage assessment
- Post-operative confirmation
Steps for Pre-operative Planning

- Measure pelvic parameters
- Remove compensation (PT)
- Measure global alignment (SVA, T1SP, TPA)
- Determine amount of correction needed/desired
- Consider other factors
- Plan levels needed to correct balance
- Simulate cages and osteotomies