AOSPINE EUROPE

AOSpine Advances Symposium
Spinal Deformity

December 03-04, 2010 Istanbul, Türkiye

Proper radiographic evaluation, parameters, clinical relevance and importance

Dr. Alpaslan Şenköylü

Session: Sagittal Plane Deformities

IMAGES IN CLINICAL MEDICINE

Severe Kyphosis

Boris Blechacz, M.D.
Ognjan Gajic, M.D.

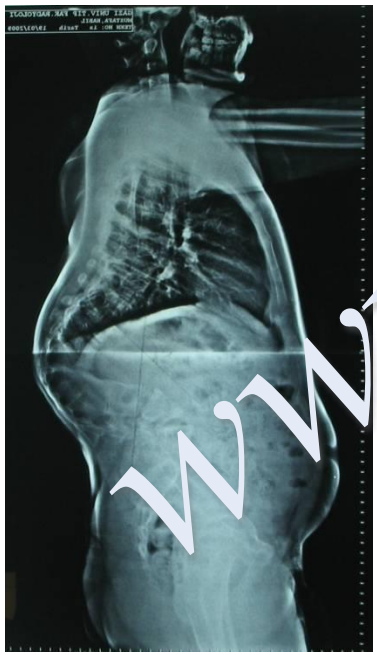
Mayo Cl
Rochest

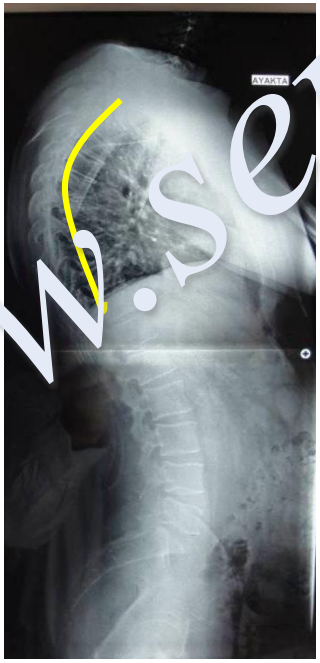
AN [illegible]-YEAR-OLD WOMAN WAS ADMITTED TO THE HOSPITAL WITH HYPERCAPNIC RESPIRATORY FAILURE. She had a long history of osteoporosis. Bone densitometry revealed a T score for the lumbar spine of −4.8. She was taking subtherapeutic vitamin D and calcium supplements and had declined treatment with bisphosphonates. Over a period of 4 years, her T score declined further, to −5.0. A radiographic study showed multiple vertebral compression fractures that resulted in serious kyphosis. Progressive dysphagia secondary to thoracic deformity developed, resulting in a 26% weight loss over a period of 4 years. When she was admitted to the hospital, she reported weakness and shortness of breath. Multiple attempts at placement of a nasogastric tube were unsuccessful because of marked esophageal kinking. Her respiratory status worsened, and she ultimately required fiberoptic intubation. Attempts to wean the patient from mechanical ventilation failed, and she died 10 days after admission to the hospital. Severe kyphosis in the elderly often is due to osteoporotic vertebral fractures, which may lead to mechanical complications such as dysphagia, respiratory failure, and ultimately death.

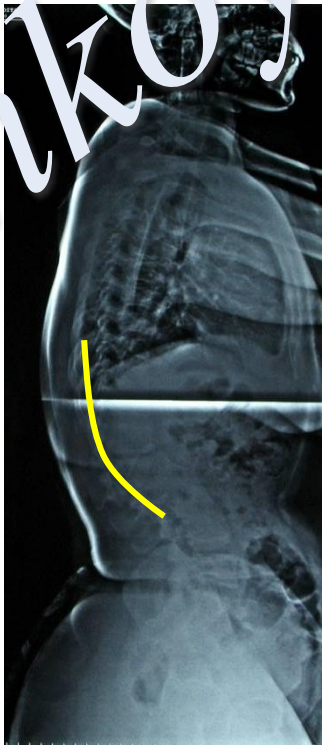
Sagittal Plan Deformities

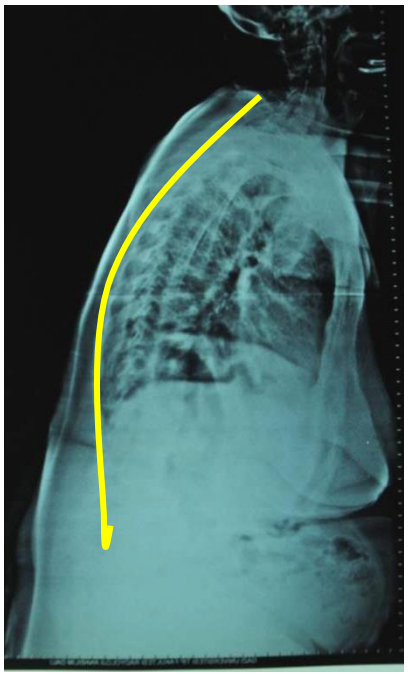
Exaggeration or deficiency of normal lordosis or kyphosis

- Congenital-developmental disorders
- Inflammatory disorders
- Degenerative disoders
- Post-traumatic disorders





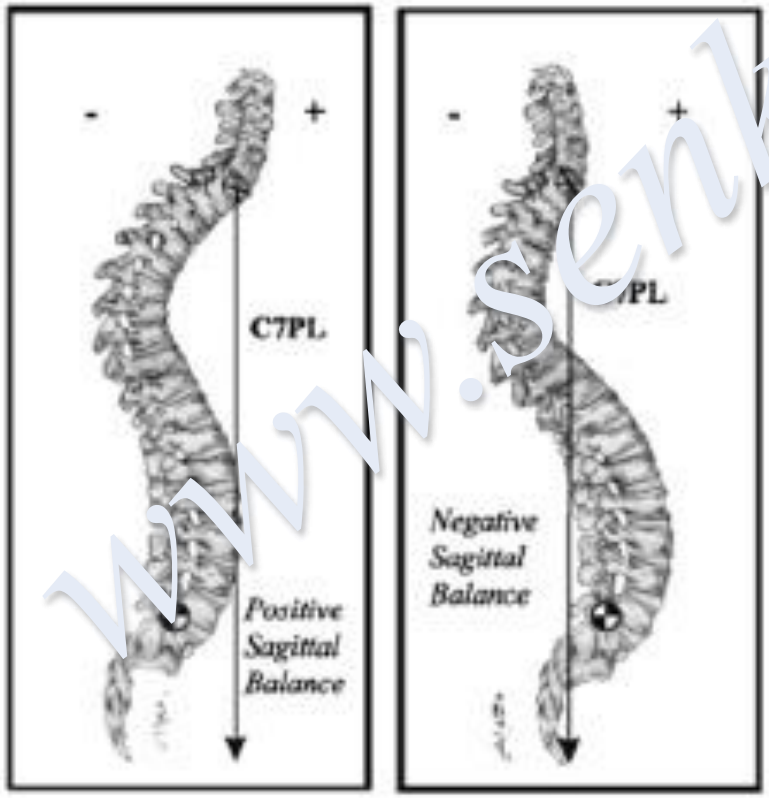


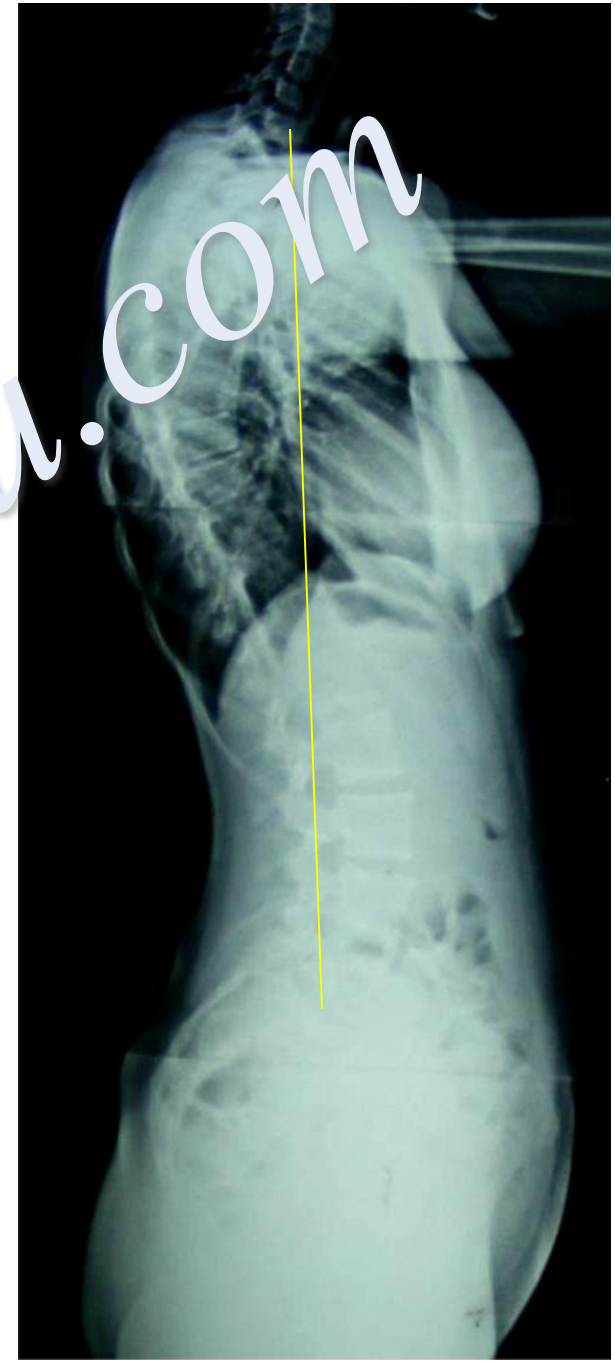


What is normal sagittal balance?

Definition of SRS:

SVA lies within ±2 cm of the sacral promontorium





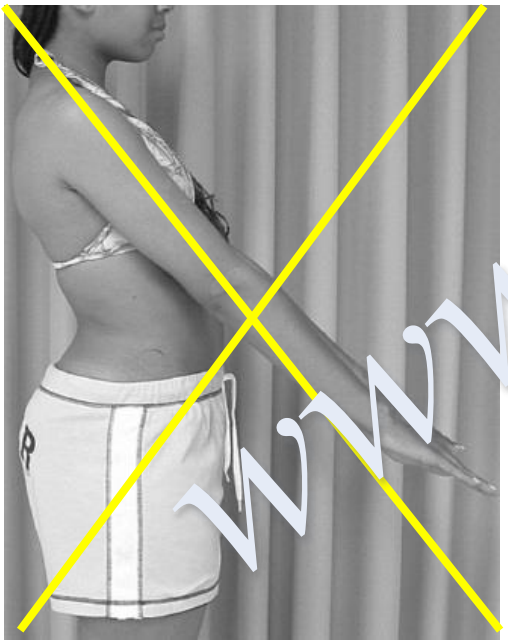
Position of the patient

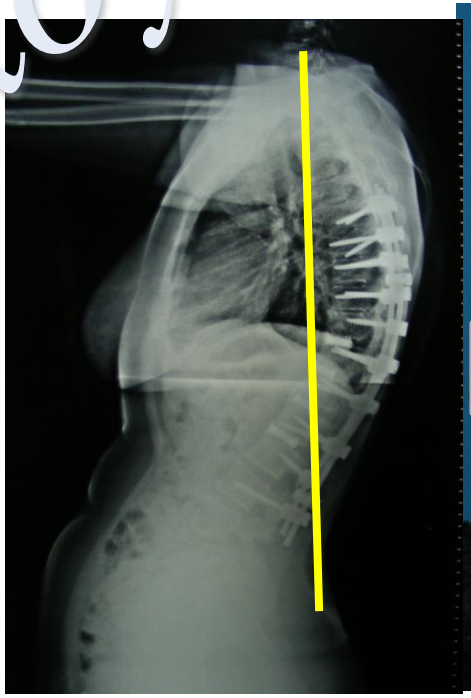
- Fists on clavicules position

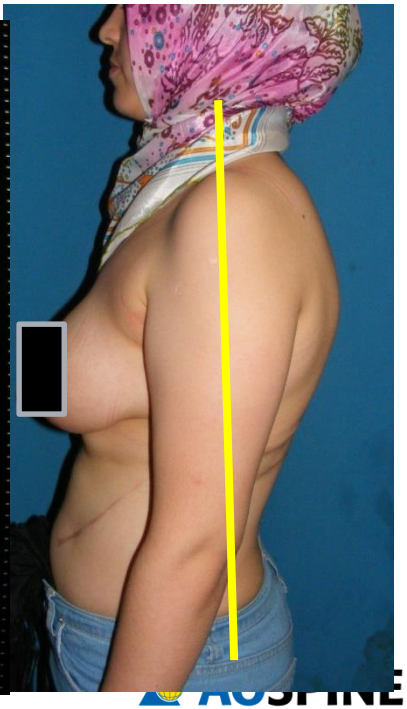
Faro FD et al, Spine, 29:2284-9, 2004

- Arms forward at 30-90 degrees and resting on a support

Çil A et al, Spine, 30: 93-100, 2004

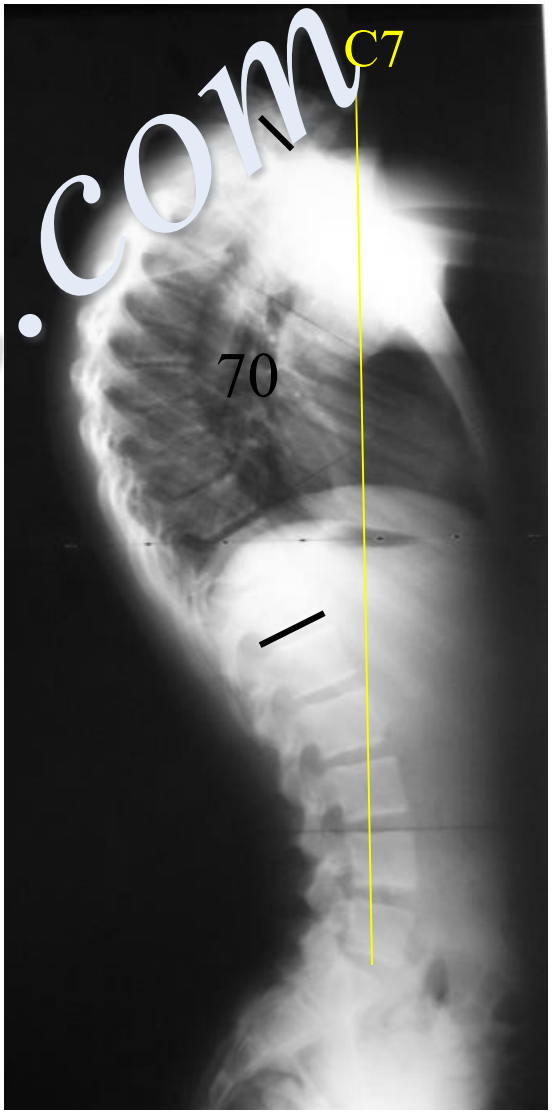






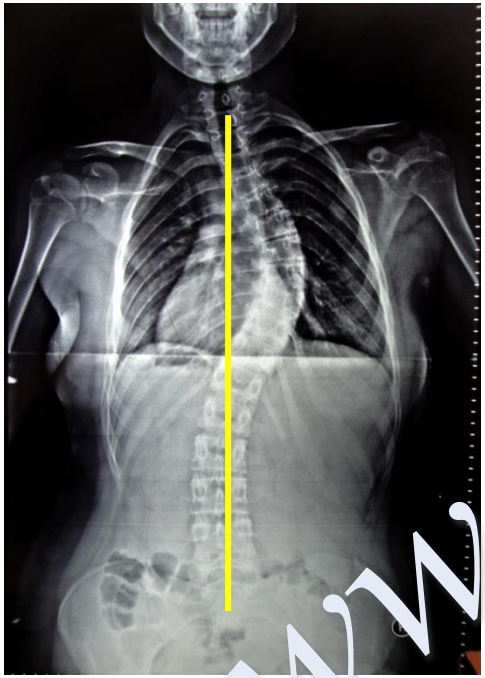
Does normal balance mean normal alignment?

NO!

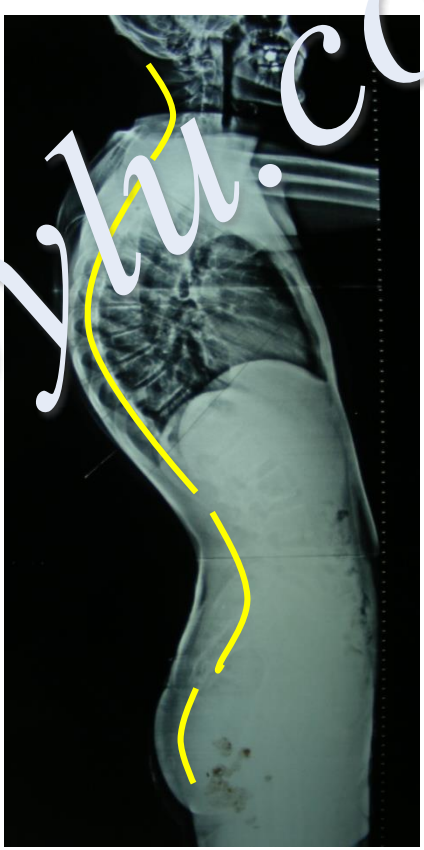


Measurement of curvature

Nomenclature



Scoliosis= clear



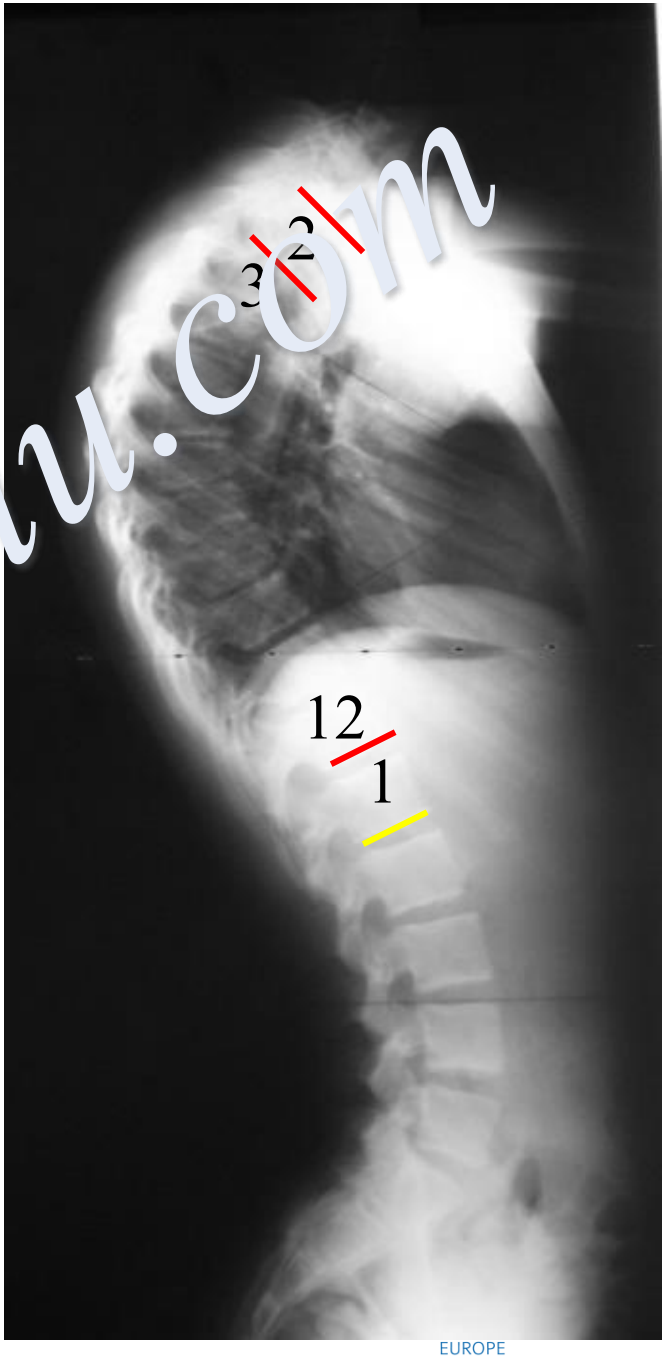
Kyphosis= unclear

Which level is better?

T2-T12 , T3-12, T4-12,

or

most tilted vertebrae



Which levels are maximally tilted?

n=121 normal subjects

- T2-12 → **49 %**
- T2-L1 → 13 %
- T2-T11 → 10 %
- T1-12 → 10 %
- T3-12 → 7 %
- Others → 11 %

Boseker EH et al, J Pediatr Orthop, 20:796-8, 2000

What is normal for Th Kyphosis?

SRS Guidelines → 20-40 degress??

- T1-12 kyphosis → -55±10 (37-72)

  Çil A et al, Spine, 30: 93-100, 2004

- T4-most tilted vertebra distally → -37 (7-63)

  Stagnara P et al, Spine, 7: 335-42, 1982

- T5-12 kyphosis → -64 ±10 (9-66)

  Gelb DE et al, Spine, 20:1351-8, 1995

Intra and Interobserver Error of Measurement??

The mean intra-observer agreement interval for kyphosis angle measurement techniques ranged from ±7.1 to ±9.3

The mean interobserver agreement interval for kyphosis angle ranged from ±8.2 to ±11.1

Alanay A. et al, Eur Spine J, 16:2126-32, 2007

T1 Sagittal Angle

ELSEVIER

The Spine Journal 10 (2010) 994–998

THE SPINE JOURNAL

Technical Report

The use of the T1 sagittal angle in predicting overall sagittal balance of the spine

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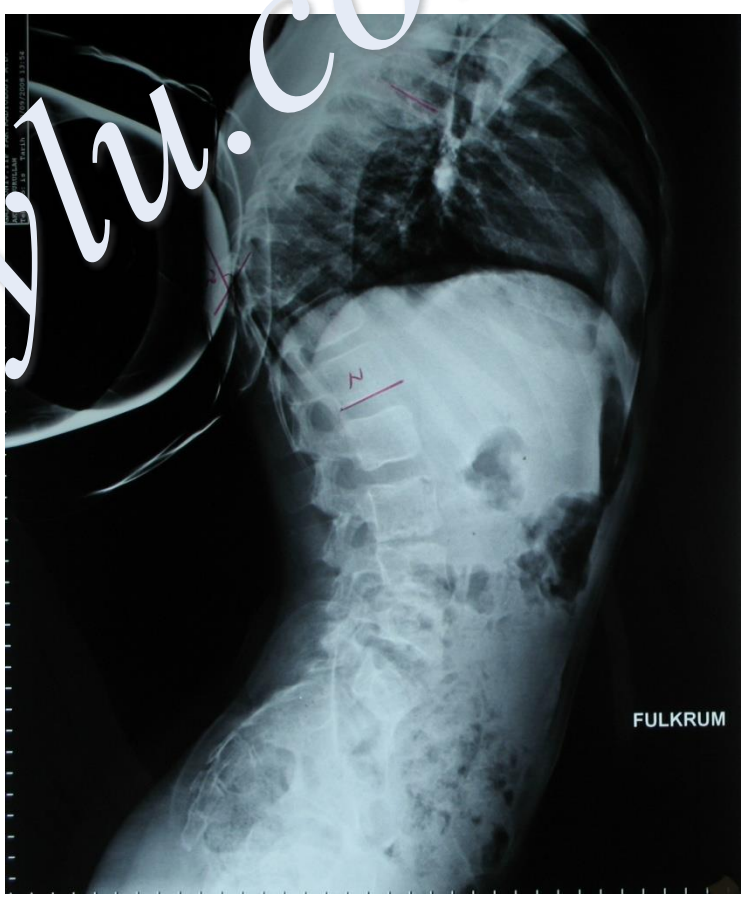
If the T1 tilt > 25° → at least 10 cm of positive sagittal imbalance
If the T1 tilt <13° → negative sagittal balance
Useful when long films cannot be obtained

Flexibility of the curve in sagittal plan

Very important for the surgical strategy

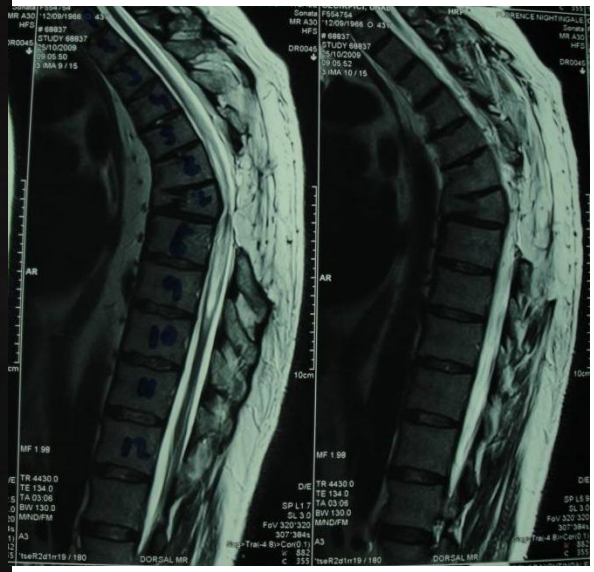
Necessity of release or osteotomy



- Fulcrum extension
- Suspension
- Traction under general anesthesia

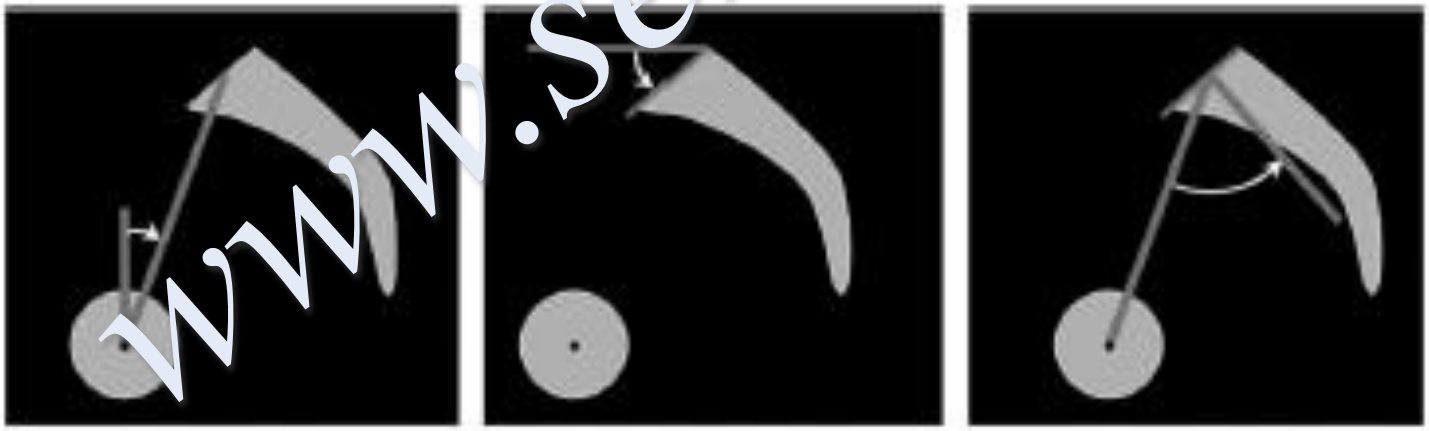
Other Imaging Modalities

- CT Scan
- MRI

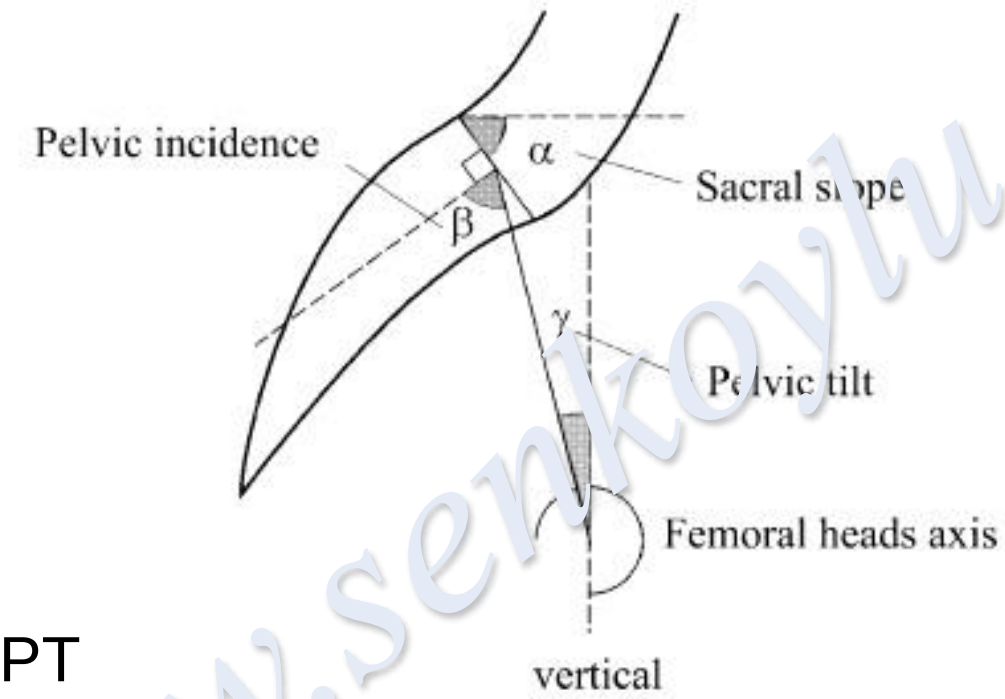


Pelvic Parameters

- Non Morphologic:
  - Sacral Slope
  - Pelvic Tilt
- Morphologic
  - Pelvic İncidence



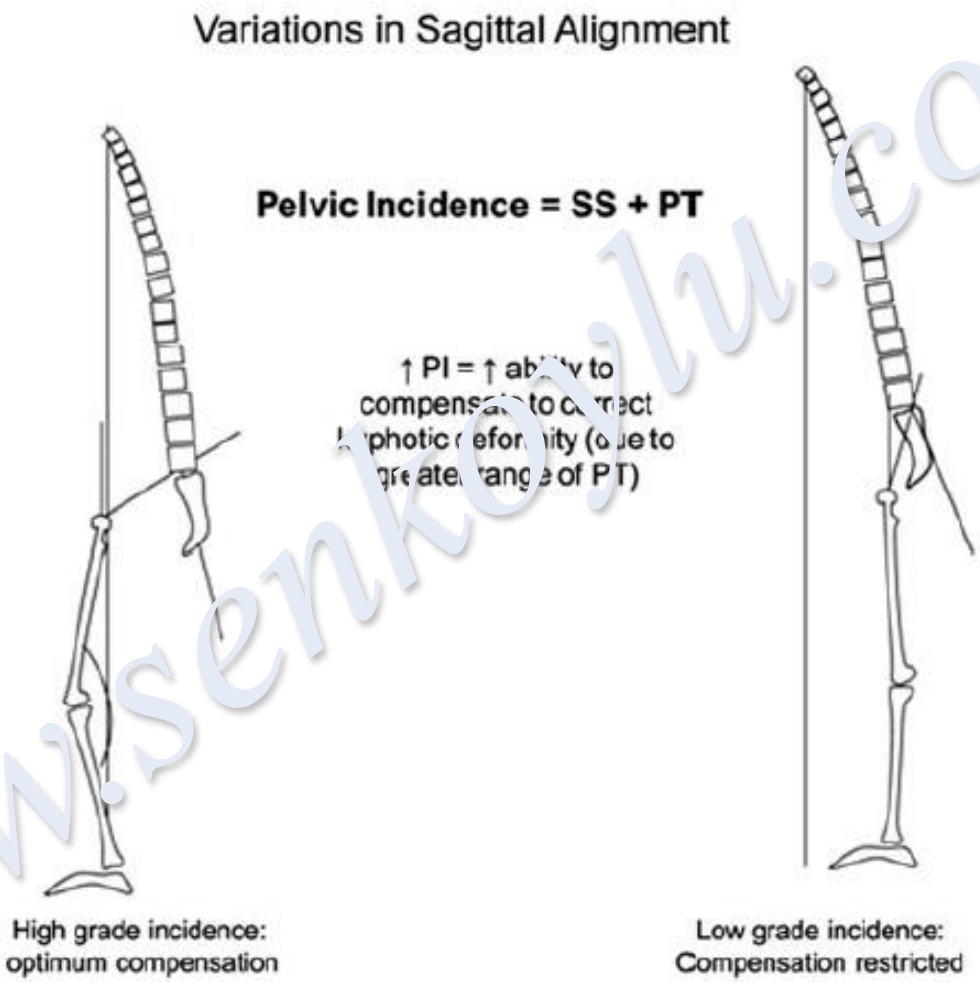
Pelvic Incidence (PI)



PI= SS+PT

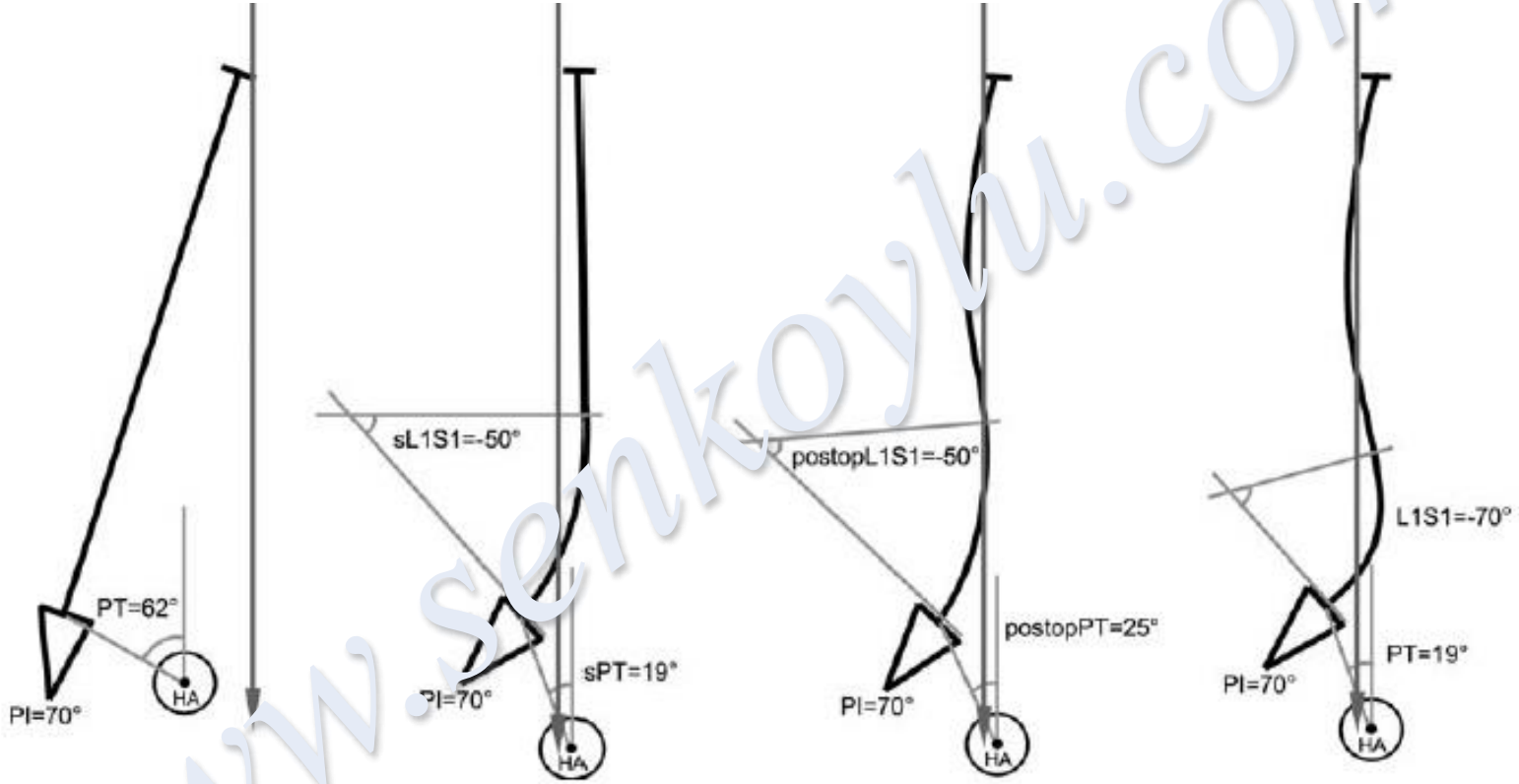
Boulay C et al, Eur Spine J, 15:415-22, 2006

PI-Compensation



Roussouly P and Nnadi C, Eur Spine J, 19:1824-36, 2010

Relation of PI with PT



Aurouer N et al, Surg Radiol Anat, 31:781–792, 2009

Estimating of Lumbar Lordosis with PI

Direct correlation between pelvic position and HRQLA's

LL=PI +9 (±9)

Schwab F et al, Spine , 34: 1828-33, 2009

In PSO patients better SVA value obtained with

LL ≥ TK+PI - 45

Mulconrey DS et al, 42. SRS Annual Meeting, Edinburgh, p86, 2007

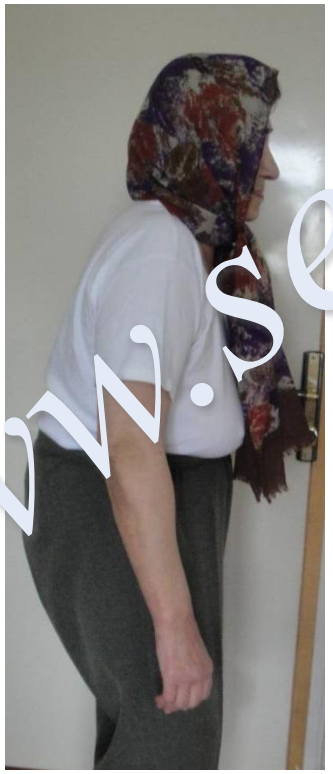
Sagittal Parameters Correlate with SRS Self-Image Scores in PSO

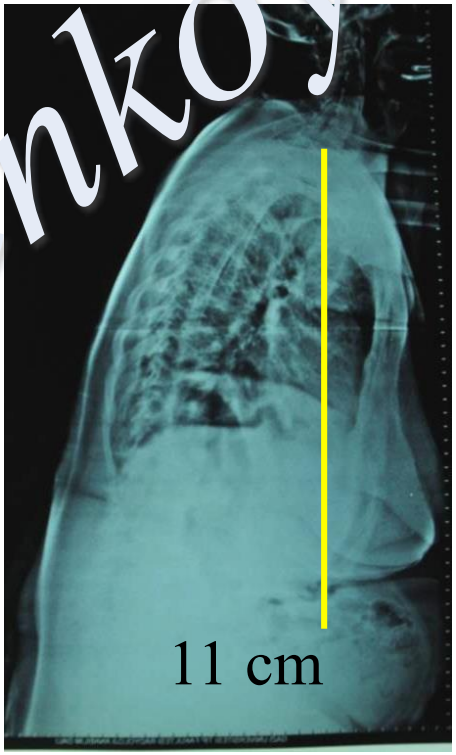
Associated factors		Total patients (n=102)	Better SI score(n=43)	P value
SVA	<5cm	56	3	0.003
	>5cm	46	121	
C7 plumb to bicoxofem head	<0cm	67	34	0.015
	>0cm	35	9	
T12 plumb	<-1cm	43	24	0.017
	>-1cm	59	19	
TK+LL+PI	<55 deg	75	36	0.046
	>55 deg	27	7	

Bridwell K et al, 43.SRS Annual Meeting, 2008, Salt Lake City, 161-2

Clinical Relevance (Normal Sagittal Balance)

- Harmonious alignment of the trunk
- Allows to stand with spending the least amount of energy





SPINE Volume 30, Number 6, pp 682–688

Correlation of Radiographic Parameters and Clinical Symptoms in Adult Scoliosis

Level of Evidence-3

Steven D. Glassman, MD,* Sigurd Berven, MD,† Keith Bridwell, MD,‡ William Horton, MD,§ and John R. Dimar, MD*

- Two cohorts:
  - A.No prior surgery n=172
  - B. Prior surgery n=126
- Evaluation criterias:
  - Radiographic measurements (coronal and sagittal)
  - HRQLA's (ODI, SRS-22,SF-12)
- Conclusion:
  - Positive sagittal balance means poor HRQLA in both groups
  - Coronal imbalance >4 cm→poor pain and function scores in group A

Ideal Ratio Between T-kyphosis L-lordosis

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An Analysis of Sagittal Spinal Alignment Following Long Adult Lumbar Instrumentation and Fusion to L5 or S1: Can We Predict Ideal Lumbar Lordosis?

Yongjung J. Kim, MD,* Keith H. Bridwell, MD,* Lawrence G. Lenke, MD,*
Seungchul Rhim, MD,† and Gene Cheh, MD*

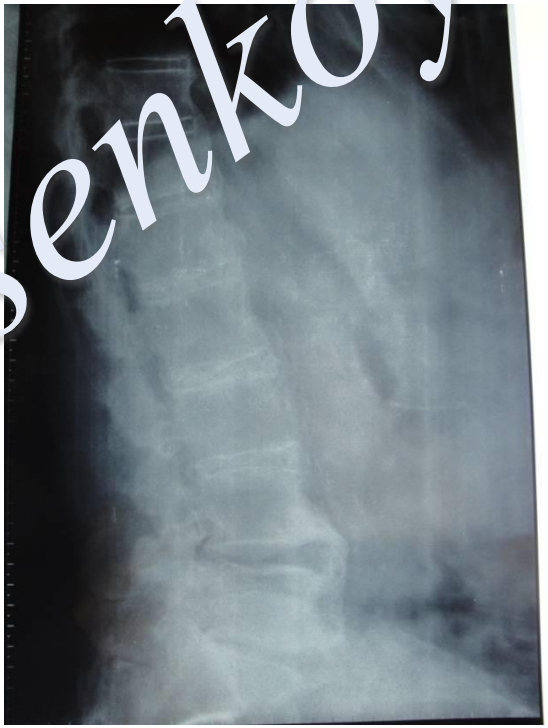
Risk factors for the suboptimal sagittal balance:

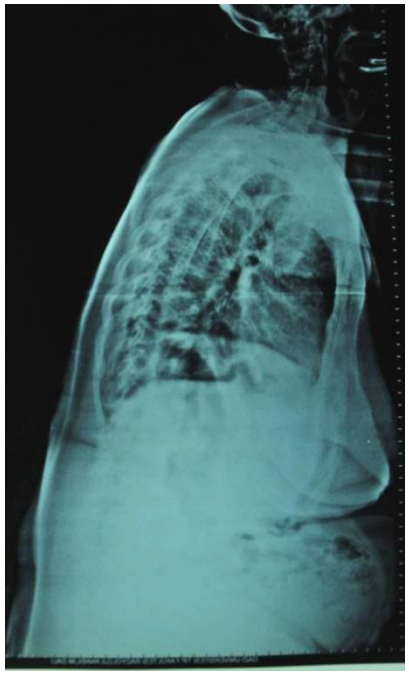
1. Thoracic kyphosis+Lumbar lordosis+Pelvic incidence>45
2. Age >55 year
3. Postop lumbar lordosis-thoracic kyphosis<20
4. Sagittal imbalance > 5 cm
5. Be careful for the hyperlordosis

Clinical Presentation of Sagittal Problems

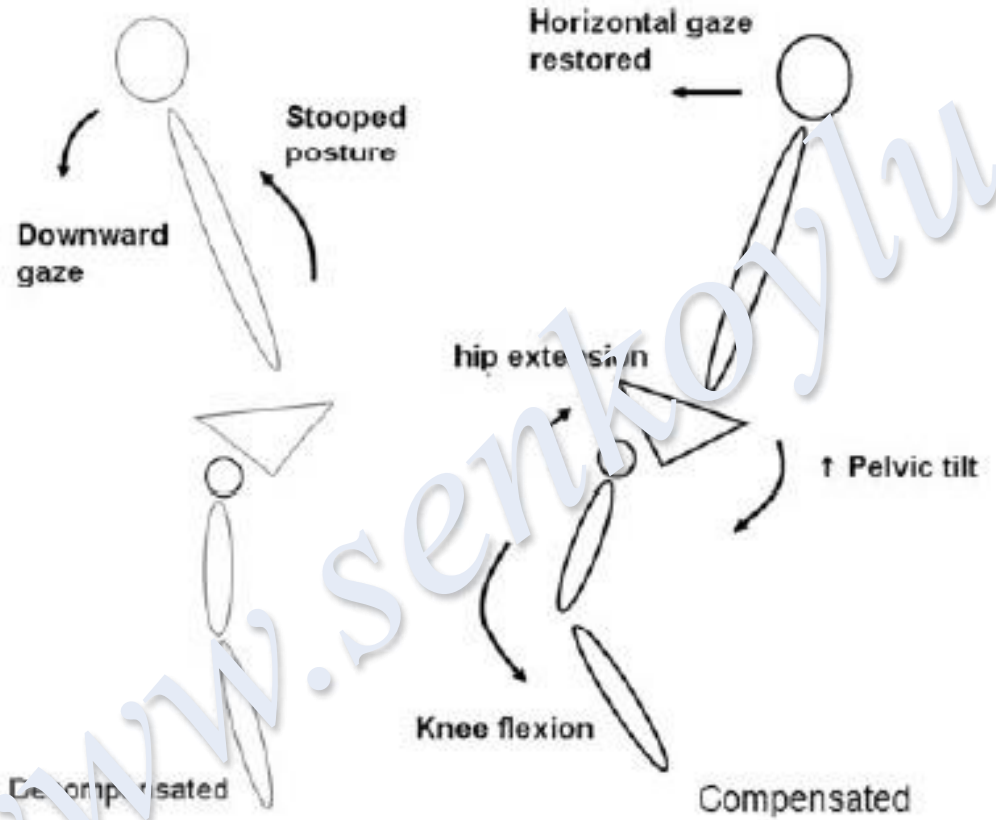
Tri-modal age distribution:

1. Teenagers: Scheuermann's kyphosis
2. 40-50 year age: Inflammatory disorders (Ankylosing spondylitis etc.)
3. Over 60's: Degenerative arthritis





Compansation of Sagittal Imbalance



Roussouly P and Nnadi C, Eur Spine J, 19:1824-36, 2010

Sagittal Alignment in Aging Spine

Glassman SD et al, Spine, 30:2024–9, 2005

Conclusions

- Normal sagittal balance does not mean normal alignment
- Measure the T kyphosis between the most tilted vertebrae (T2-12)
- Normal T kyphosis is between 20-40 degrees??
- Evaluating the flexibility
- Different imaging studies
- Most important pelvic parameter is Pelvic Incidence
- LL=PI+9 or LL>TK+PI – 45
- Those with a large pelvic incidence are able to compensate sagittal imbalance better
- Avoid the positive sagittal balance

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Thank You

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