Planning for Optimal Outcomes: The Role of Sagittal and Coronal Alignment

Innovasis Spine Symposium 2019
Deer Valley, Utah

P. Justin Tortolani MD
Chief, Spine Surgery and Fellowship Director
MedStar Union Memorial Hospital/MedStar Orthopaedic Institute
Professor, Georgetown University School of Medicine

GEORGETOWN UNIVERSITY
School of Medicine

MedStar Union
Memorial Hospital

Deformity Logic

IF…

- Life (Gravity) α Poor Sag Balance and Pelvic Compensation (Sir Isaac Newton – 1700s) "Life is a kyphosing event"
- Poor Sagittal Balance α Pain and Disability (Glassman et al 2005)
- Pelvic Compensation α Pain and Disability (Schwab et al 2013)

Then…

- Life α Pain

Conclusion:

- Enjoy it while you can!!!

Glassman et al, Spine 2005:30(18)20;2024-29
Schwab et al, Spine 2013::38(13):E803-E812.

2 Main Issues

- Identifying reasonable candidates
- Achieving spinal balance.

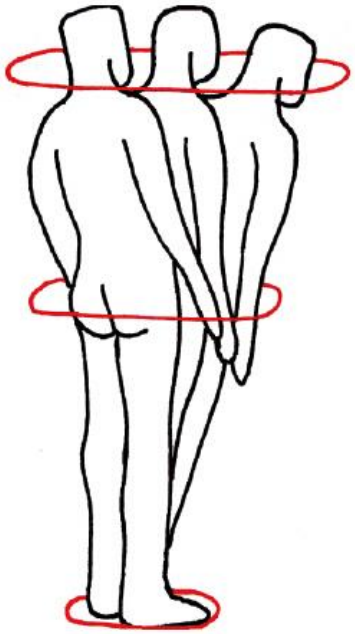


Figure 2 Hen in the center of this "cone of economy" the body may remain in an ergonomically favorable erect position. Larger deviations outside this cone will require external support to be reimbalanced.

Patient Selection

- Pain:
  - Location and pattern
  - Back vs Leg
  - If Axial/Back:
    - Flat back?
    - Mechanical and relieved with rest?
    - At apex?
  - If Radicular/Leg:
    - Mono-radicular?
    - Reproduce with side bending?
- Flatback:
  - Muscle fatigue with standing
  - Lower lumbar
  - Complete relief with leaning or sitting
  - More bent over course of the day

Patient Selection

- Demographics
  - Age
    - Physiologic Age
    - > 75
    - Older patients may do better
  - Comorbidities
    - Major Cardiac
    - Prev PE
    - Stroke
    - Dementia
    - Renal
    - Morbid Obesity
    - Immunodeficiency
- Bone Health
  - Osteoporosis: DEXA < -2.5
  - Should check on everyone
  - Pre-op optimization
- Nicotine
- ETOH
- BMI < 40

Patient Selection

- Psychosocial
  - Depression History
  - Employment status
    - Can they return?
    - What's realistic?
  - Marital Status

  * Family support/engagement (can be a disaster)

- Setting realistic expectations
  - Back pain vs leg pain relief
  - PJK risk
  - 50% complication rate
  - Revision surgery risk
  - Timing on return to work
- Self-reported outcomes
  - ODI, VAS, SRS-22, SF-36, Eq5D

TABLE 1. Factors included in the ASD-FI

Health deficits
Documented by physician
>3 medical problems
Body mass index <18.5 or >30 kg/m^2
Cancer
Cardiac disease
Currently on disability
Depression
Diabetes
Hypertension
Liver disease
Lung disease
Osteoporosis
Peripheral vascular disease
Previous blood clot (deep vein thrombosis/pulmonary embolism/ stroke)
Smoking status
Patient-reported (questionnaire, question no.)
Bladder incontinence
Bowel incontinence
Deteriorating health this yr (SF-36v2, 2)
Difficulty climbing 1 flight of stairs (SF-36v2, 3e)
Difficulty driving a car (LSDI, 3)
Difficulty getting dressed (SF-36v2, 3j; LSDI, 1 & 2)
Difficulty getting in/out of bed (LSDI, 6)
Difficulty sleeping >6 hrs (ODI, 7)
Difficulty walking 100 yards (SF-36v2, 3i)
Difficulty w/ light activity (SF-36v2, 3b)
Feeling downhearted/depressed most of the time (SF-36v2, 9f; SRS-22r, 16)
Feeling tired most of the time (SF-36v2, 9i)
Feeling worn out most of the time (SF-36v2, 9g)
General health: fair/poor (SF-36v2, 1)
Inability to bathe w/o assistance (SF-36v2, 3j; LSDI, 8)
Inability to cheer up often (SF-36v2, 9c; SRS-22r, 7)
Inability to do normal work/schoolwork/housework (ODI, 10; SRS-22r, 9 & 12)
Inability to lift heavy objects (SF-36v2, 3c; ODI, 3)
Inability to travel >1 hr (ODI, 9)
Inability to walk w/o assistive device (ODI, 4)
Leg weakness
Loss of balance
Not in excellent health (SF-36v2, 11d)
Personal care dependency (ODI, 2)
Restricted activity level (SRS-22r, 5)
Restricted social life (ODI, 8; SRS-22r, 14 & 18)

LSDI = Lumbar Stiffness Disability Index; ODI = Oswestry Disability Index; SF-36v2 = 36-Item Short-Form Health Survey, version 2; SRS-22r = Scoliosis Research Society-22r questionnaire.

Frailty Index

- 40 variables list: (score=#items/40)
- Normal: 0-0.3
- Frail: 0.3-0.5
- Severely Frail: > 0.5
- Not practical for routine use

Miller et al, Neurosurgical Focus. 2017: 43(6)E3

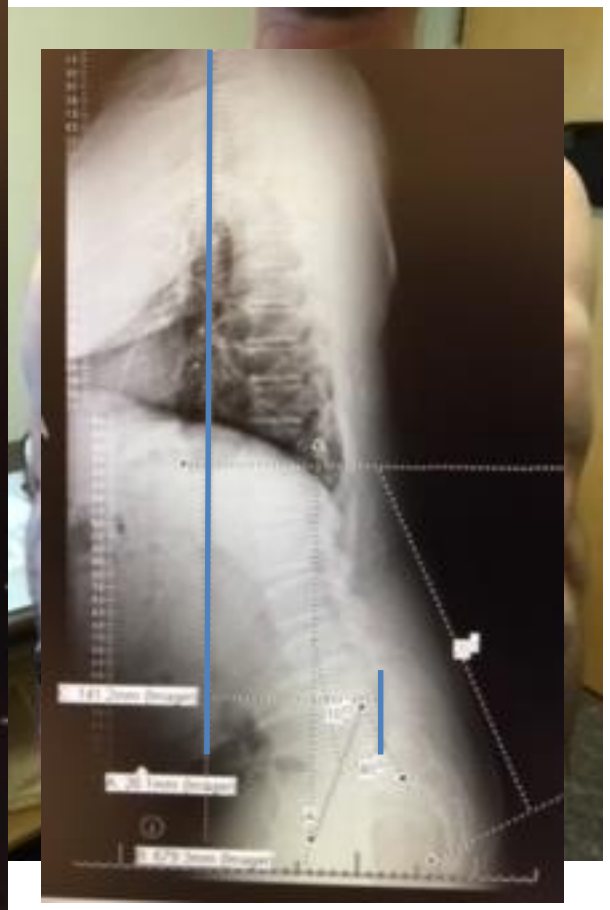
Union Memorial Resident Index*

- Hyphenated names
- More allergies to meds than meds
- Allergy to > 2 opioids
- Work for Soc Sec Admin
- Adults with stuffed animals
- Copper-colored hair
- Women with hats
- Ethnic attire of different ethnicity
- Sunglasses indoors
- Fibromyalgia
- Hair stylists
- Flight attendants
- Injuries caused by video games
- “horse people”
- “high pain tolerance”
- Pain >> 10
- Combinations of any of the above

*MedStar Union Memorial Residents and Staff: 2008-present

Physical Exam

- Coronal Deformity
  - Is it flexible?
    - Side bending
  - Passively correctible?
    - Hands on Apex
  - Where is it?
- Sagittal Deformity
  - Is it fixed?
    - AS
    - Previous surgery
    - Over bolster xray
  - Compensated
    - pelvic retroversion?
    - Knees and Hips Flexed?
    - Scapula extended?
  - Hip and Knee contracture
  - Location? (upper thoracic, mid or lower thoracic, lumbar)



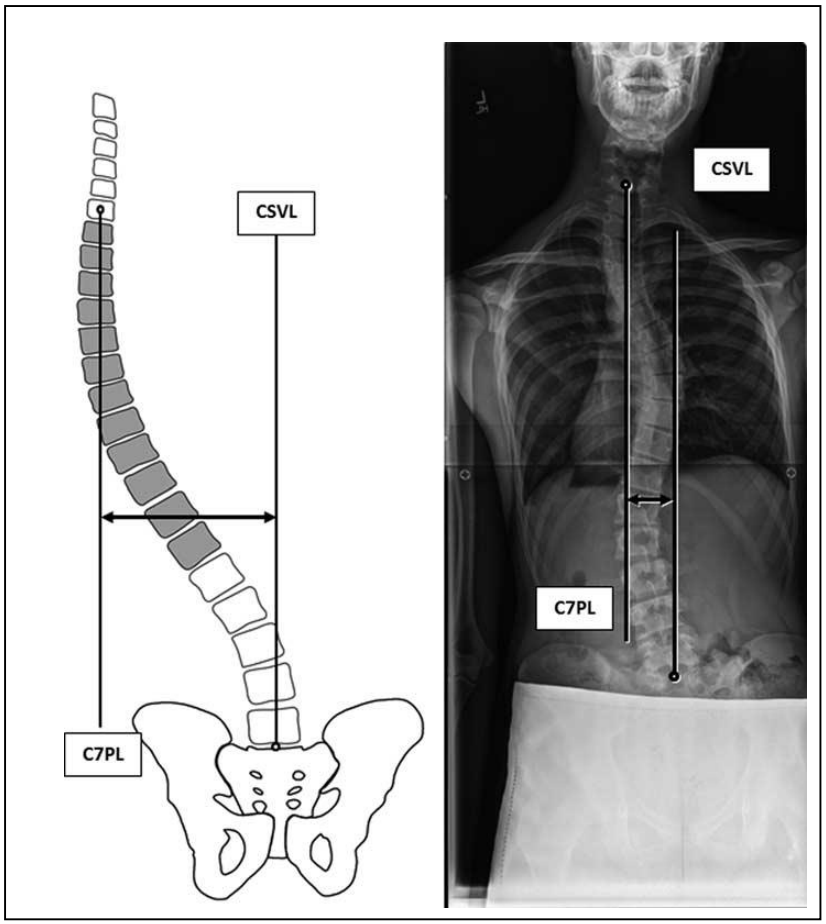
C7 Plumb: + 14cm. Not extending through lumbar spine!!

Radiographic Evaluation

- PA and lateral full cassette radiograph
- Knees and hips fully extended
- No external support
- Arms folded and hands fisted over clavicle

Bess et al. Clin Spine Surg. 2016, 29(1).6-16

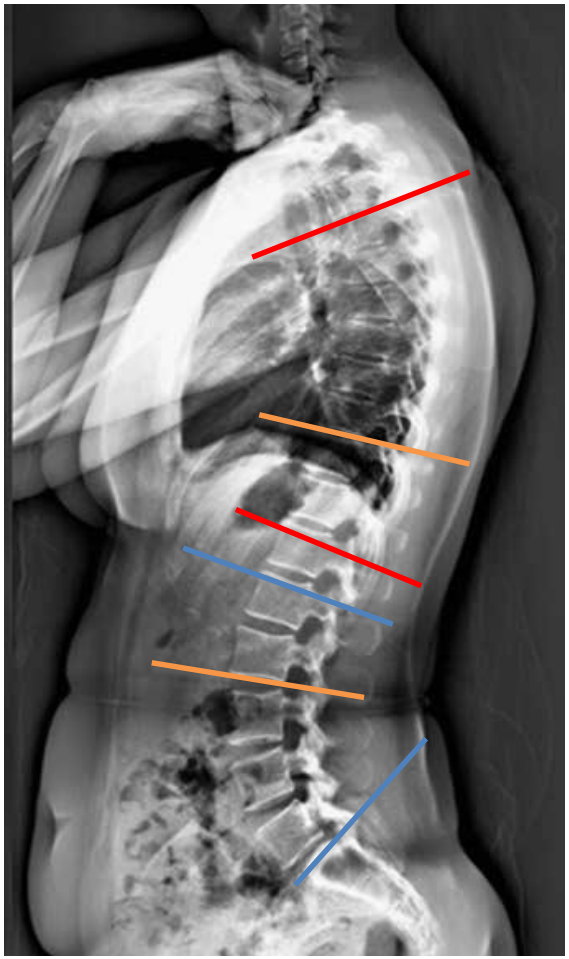
Coronal Plane Analysis



- Cobb of all curves
  - T, T/L, L, and L/S fractional
- Lateral listhesis
- Coronal Alignment (C7 plumb to CSVL) (<4cm)

Bess et al. Clin Spine Surg. 2016, 29(1)6-16

Sagittal Plane Analysis

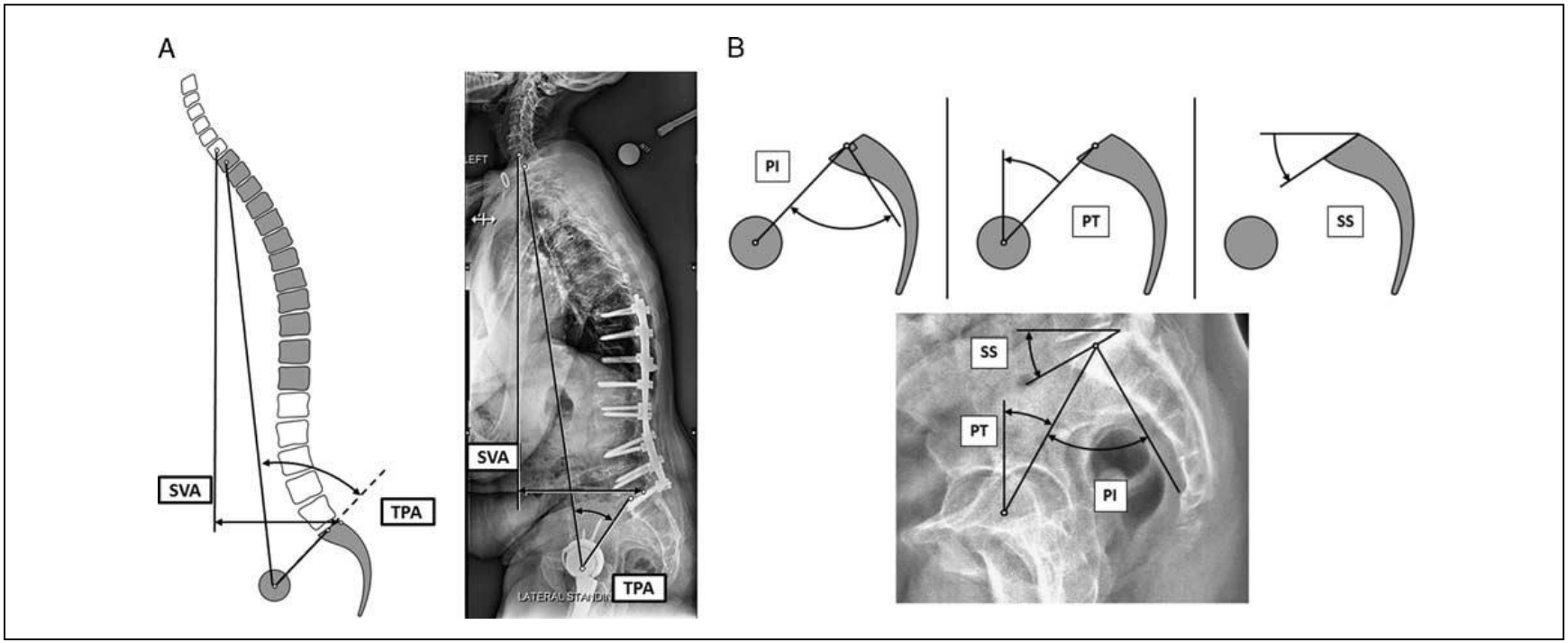


- Regional
  - TK (T4-T12)
  - TLK (T10-L2)
  - LL (L1-S1)

Bess et al. Clin Spine Surg. 2016, 29(1).6-16

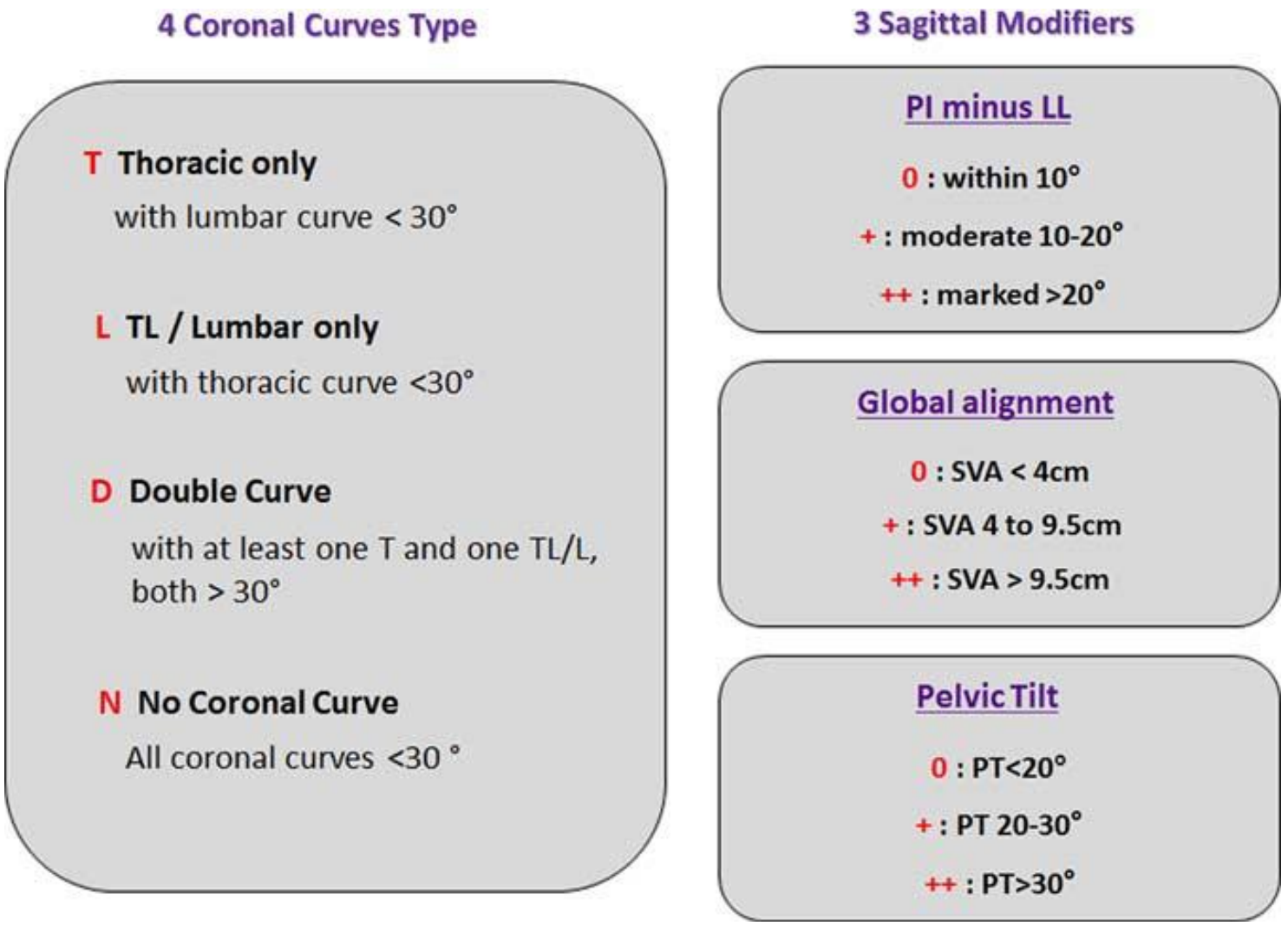
Sagittal Plane Analysis

- Global: SVA (normal < 4cm) and TPA (<10)
- Spinopelvic: PT (nl < 20) PI-LL (<10)



Bess et al. Clin Spine Surg. 2016, 29(1).6-16

SRS-Schwab: Recognition of Importance of Sagittal plane (no coronal modifier!)



Temper Correction with Age

TABLE 3. Radiographic Thresholds Based on Age-Specific ODI US-Norms

Age Group	% in Database	Mean Age in Database	ODI US-Norm*	PT	PI−LL	LL−TK	SVA	TPA
<35	17.7	26.2	9.49	11.1	−11.3	29.2	−29.1	4.4
35–44	8.8	40.7	11.77	15.5	−6.2	21.9	−4.0	10.0
45–54	19.9	51.2	15.43	18.9	−1.7	16.4	16.5	14.5
55–64	28.0	60.5	20.87	22.1	3.3	11.1	37.0	18.8
65–74	19.5	69.7	24.62	25.2	7.5	6.1	55.6	22.8
≥74	6.2	79.6	32.54	28.8	13.7	0.2	79.9	27.8

*value extrapolated using the PCS US-norm.

Lafage R et al. Spine 41(1) 2016,62-68

When does the Coronal Plane matter?

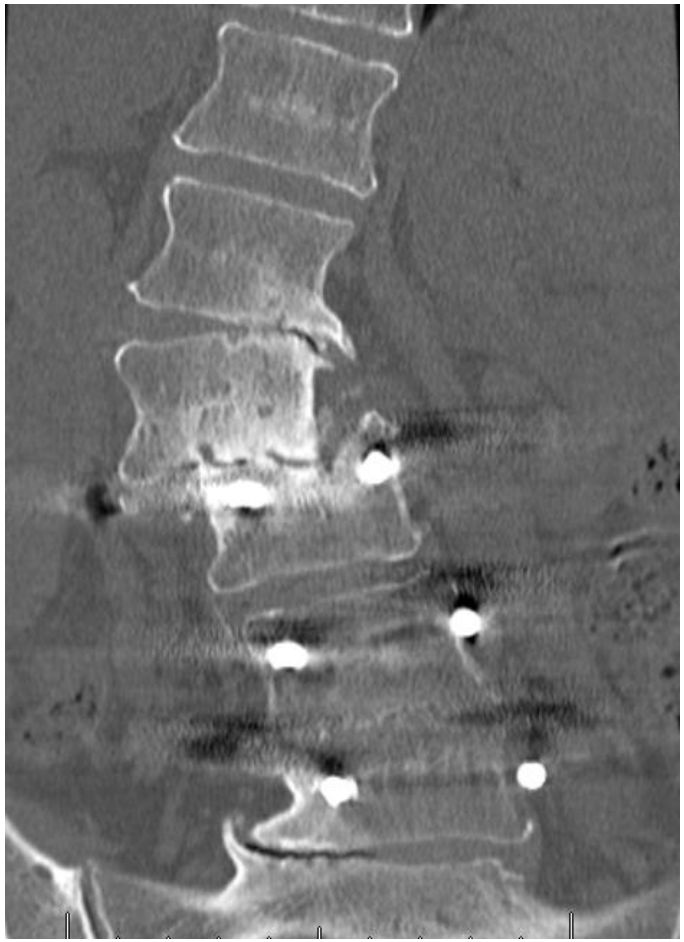
1. Fractional curve
   - Foraminal stenosis in concavity
2. Lateral listhesis
3. Coronal imbalance
   - Rare > 4cm unless neuromuscular ??
4. Selecting levels
   - UIV above the apex
   - Stable
   - Neutral
   - Level

1. Fractional Curve

- Foraminal stenosis at lumbosacral junction

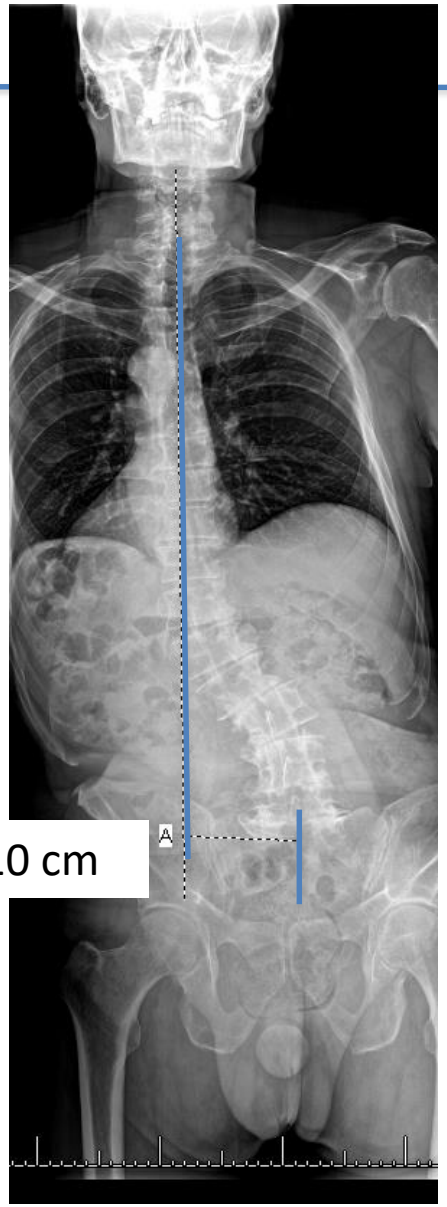
When does the Coronal Plane matter?

2. Lateral listhesis
   - L2/3, L3/4
   - Correlates with radiculopathy



Coronal Plane Considerations

3. True Coronal Imbalance
   - > 4cm

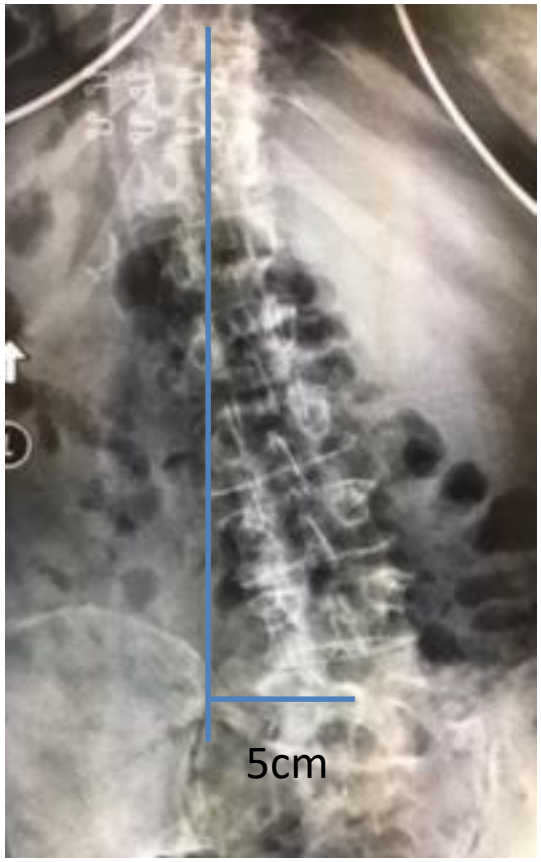


Coronal Considerations

4. Selecting UIV
   - Above apex
   - Stable
   - Neutral
   - Level (<5 deg of tilt)

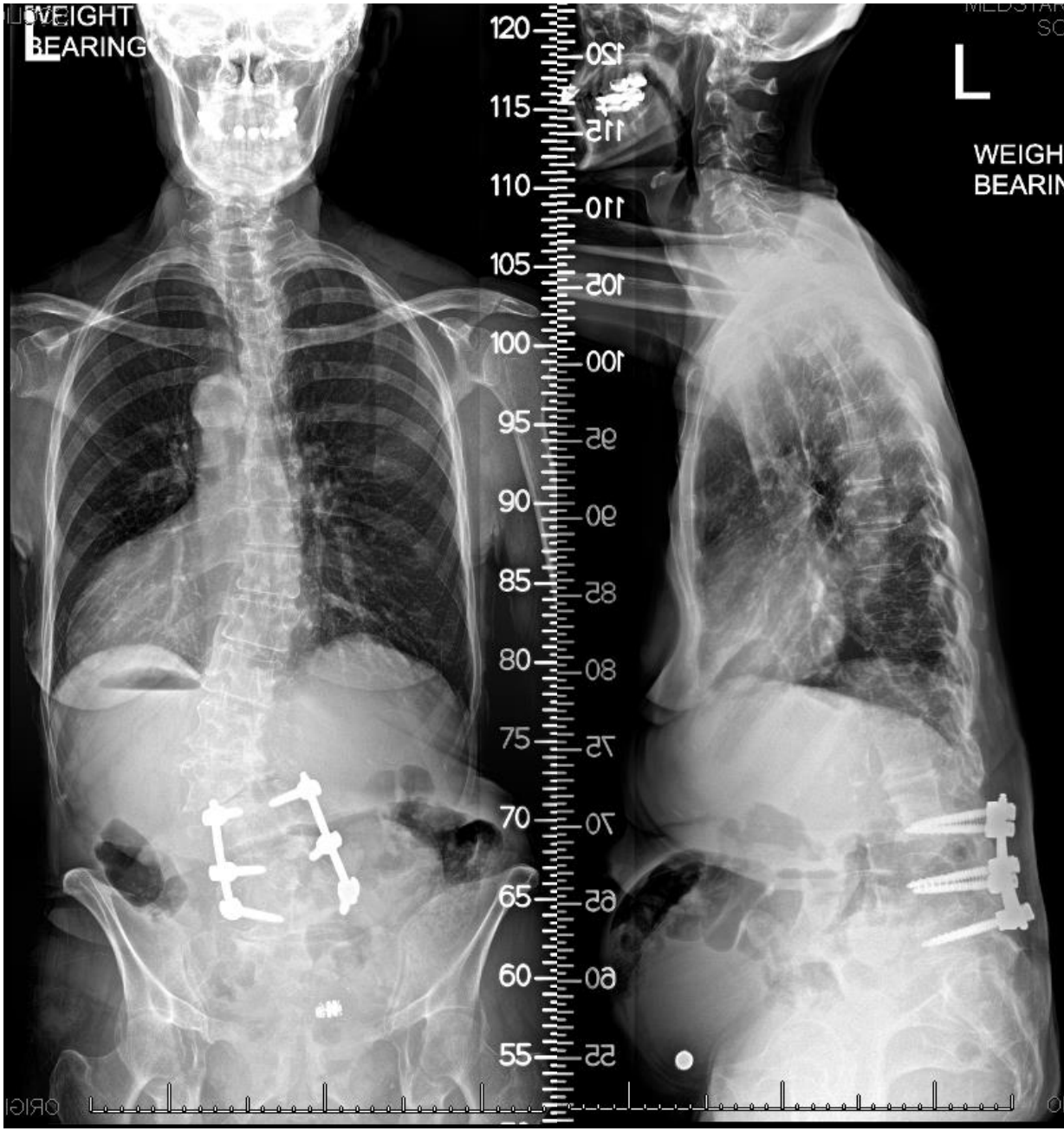
   - T10
     - Neutral
     - Level
     - Above apex

Be watchful for non-structural coronal deformity (neither AIS of adulthood or degen de novo)



Case

- 71 yo female
- PMHx
  - Anemia
  - HTN
  - TIA
  - Fibromyalgia
  - Prev L3-5
  - No Tob
  - No ETOH
  - BMI: 16
- Exam
  - Pos Sag Balance
  - Nl Neuro



Coronal Plane

- C7-CSVL: 3.7cm
- Cobb: T12-L2 = 42 deg
- R Fx'l: L3-S1 = 19 deg
- Listhesis: 1.8 cm
- L2 trapped

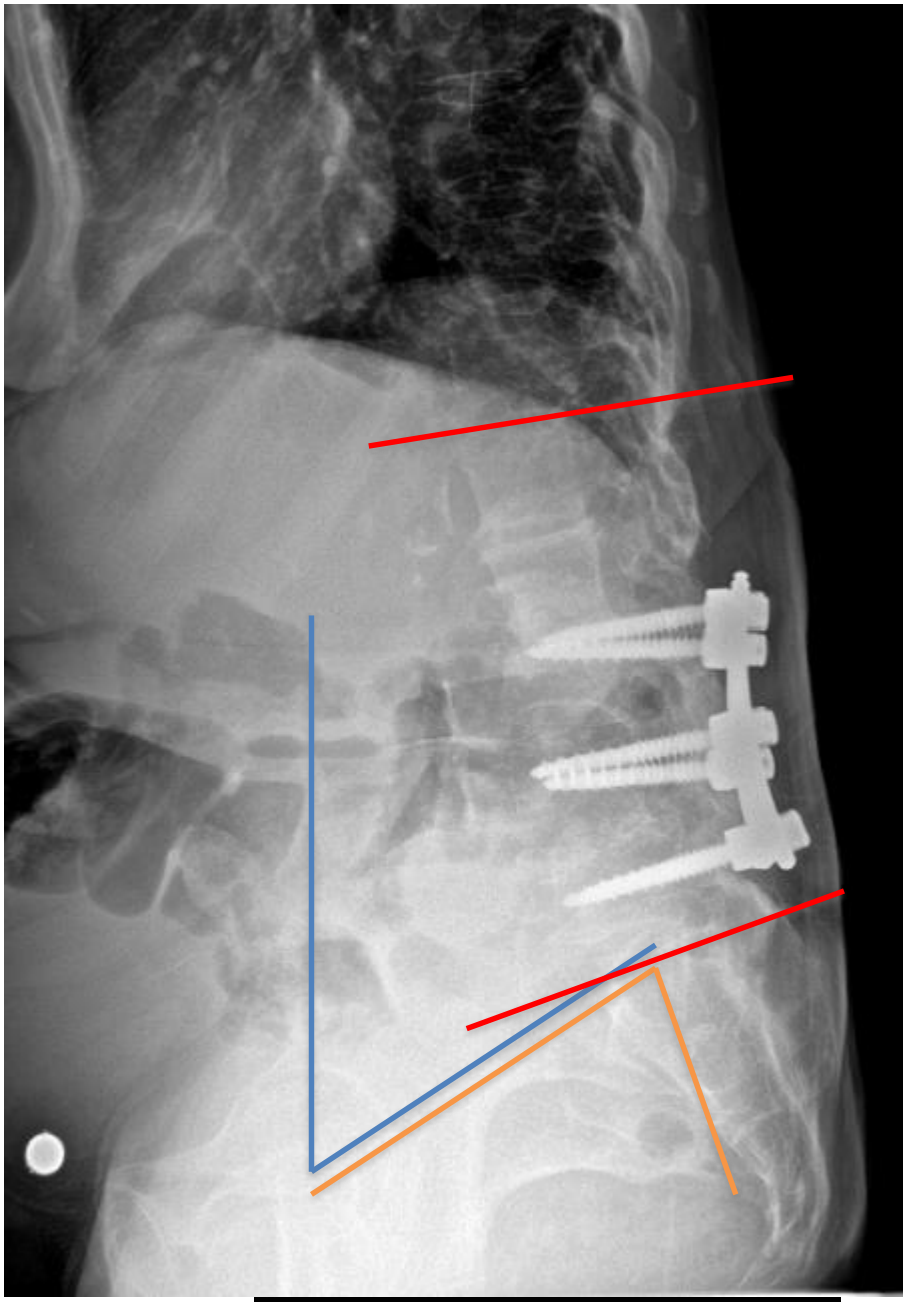
SRS-Schwab

"L"

Case

Sagittal Plane

- Regional
  - TK: 20 deg
- Global: ++
  - SVA: + 14cm (>9.5)
  - TPA: 59 deg (severe > 20)
- Spinopelvic:
  - PT: 53 deg (++) (>30)
  - LL: 11 deg
  - PI: 73 deg
  - PI-LL: 62 deg (++) (>20)



SRS-Schwab: L,++,++,++

Age-Dependent Needs

- PI-LL: 62 deg
  - Goal < 10
  - Need 52 deg
- TPA: 59 deg
  - Goal <28
  - Need: 31 deg
- SVA: +14cm
  - Goal < 8 cm
  - Need 6 cm (@2mm/deg)
  - Need 30 deg

Estimated Needs: 40 deg Lordosis

Plan

Back-Front-Back

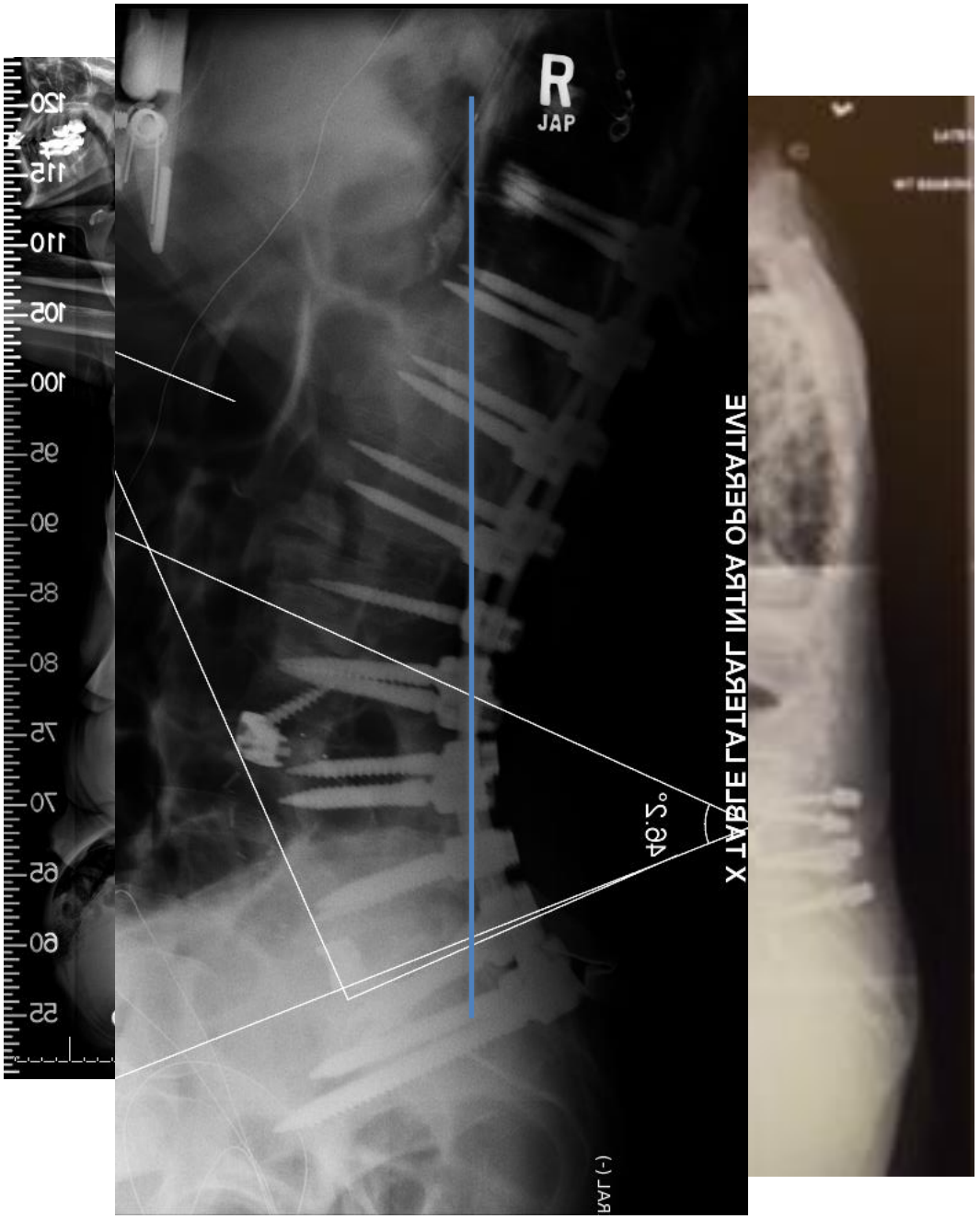
Stage I:

- Removal and Osteotomy L3/4, L5/S1
- Hyperlordotic ALIF: L3/4, L5/S1

Standing Assessment

Stage II:

- Ponte T10-L2
- PSF/Inst T10-Pelvis
- Cement Aug



Results

1 year f-u

Sagittal

SVA: 0 cm (14)

LL: 62 (11)

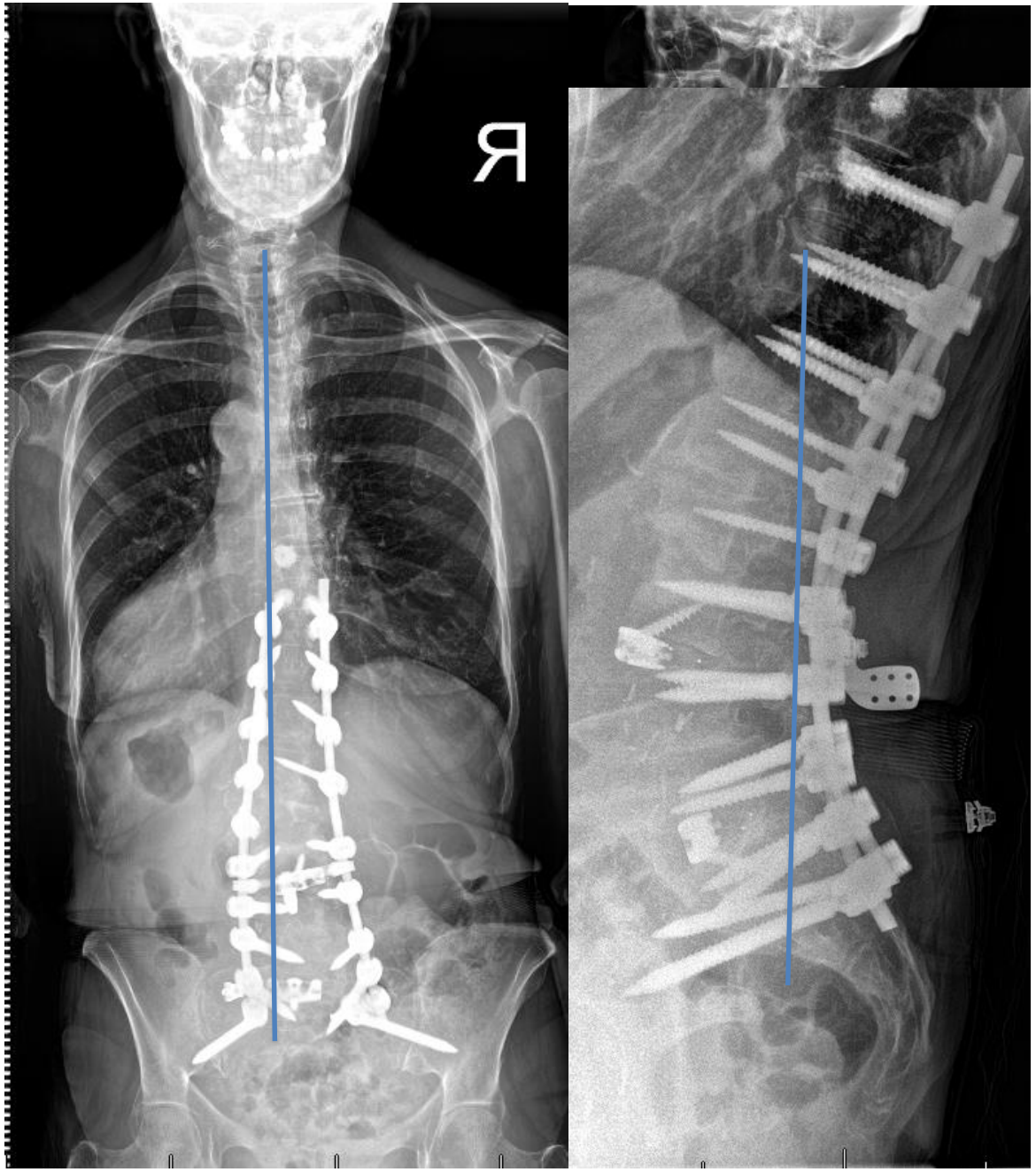
PI-LL= 9 (62)

TPA= 35 (59)

PT= 42 (53)

Coronal

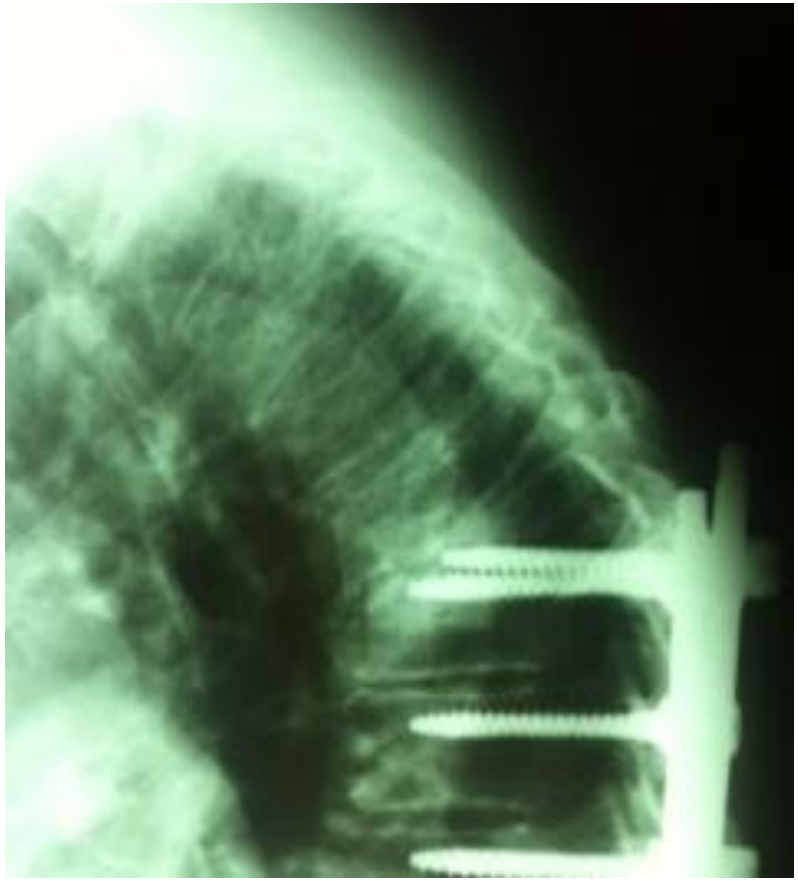
C7-CVDL= 2cm



Optimizing Outcomes: Summary

Patient Selection

- Honest Assessment
- Back Pain vs Leg Pain
  - What will likely get better
  - Residual disability?
- Major Red Flags
  - Frailty
  - Predictive Modeling

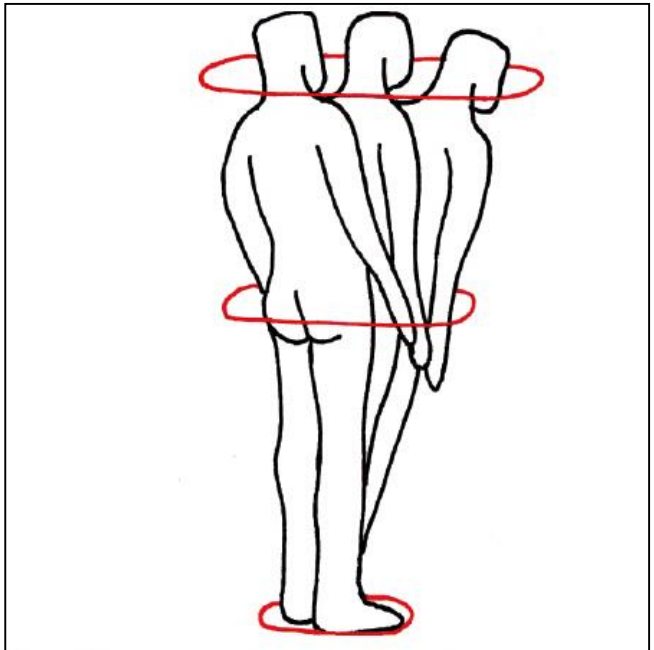


Summary

Coronal Plane

Be Strategic

- Foraminal Stenosis
- Lateral Listhesis
- Antalgia



Sagittal Plane

- Plan carefully
- Age-dependent correction
- Protect the Junctions

THANKS!

THANKS!