Spinal Deformity: Overview

AANS Special Deformity Course for Residents
Basics of Spinal Deformity Session
Saturday, March 31, 2012

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Deformity

- Read, read, read
- Learn your anatomy cold
- Spend some time with someone who has experience with deformity surgery
- No need to repeat past mistakes

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Deformity Learning

- Problem is getting people to study and read at later points in their careers
- Important to have deformity correction principles incorporated into training early on
- It is easy to stress to junior residents the need to study CV anatomy

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Deformity

- It's not just about screwing
- Proper screw placement is a minor part of the deformity correction procedure
- For most neurosurgeons, the screw placement part is the easiest
- Assymetry of pedicle sizes on the concave vs. the convex sides of the vertebral body

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Deformity Learning

- Deformity correction is not "just spine"
- Knowing how to do a routine TLIF is probably of almost no value in deformity correction surgery- some of the principles might be helpful
- There is as much work that goes into deciding who needs surgery, when the surgery is needed, and which surgery is needed

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What is sagittal plane alignment?

- Def: It is the alignment of C7 to posterior superior aspect of S1 on an upright lateral plain Xray

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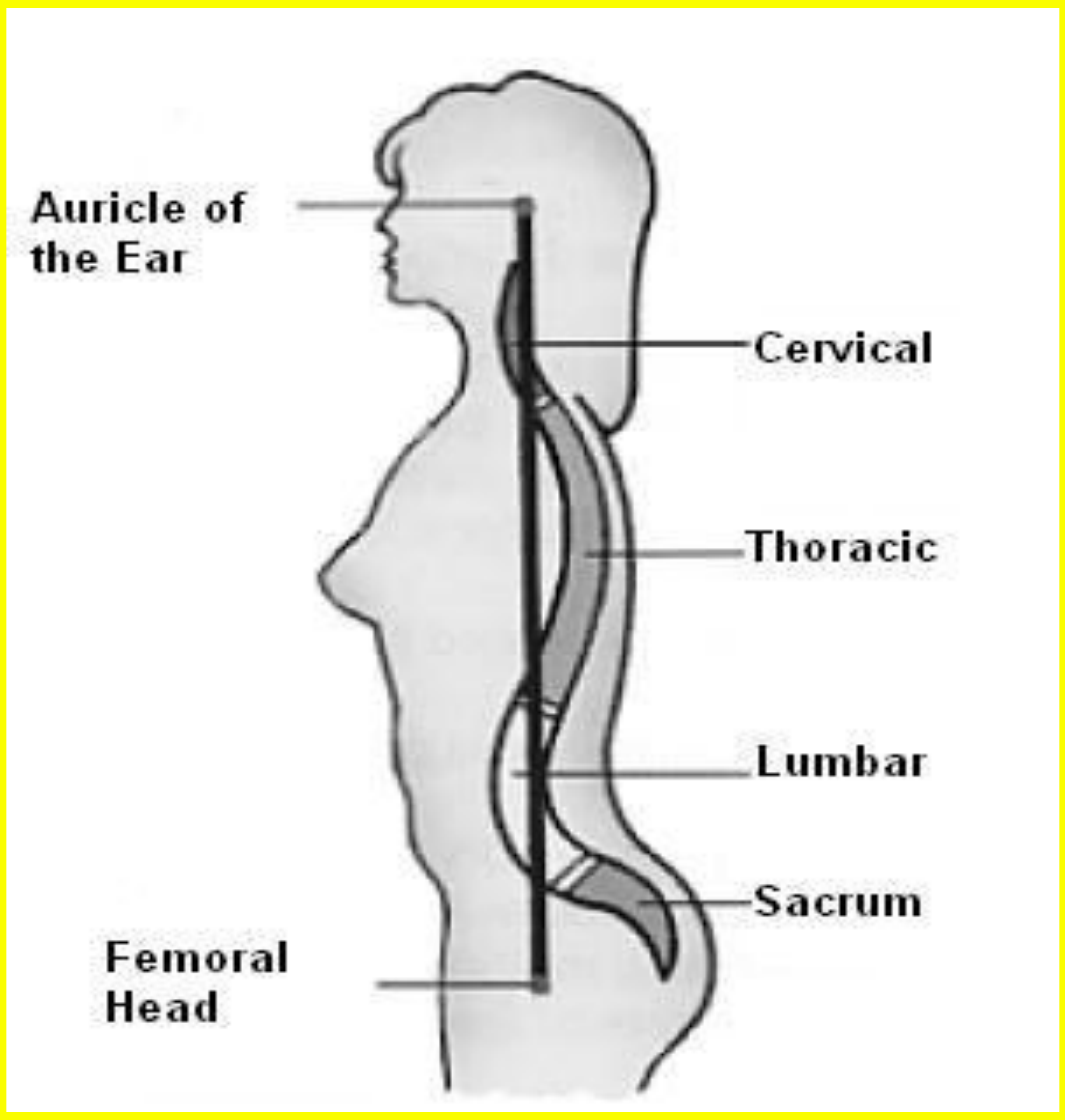
C7 Plumb line



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Measurement Criteria

- A lateral chest X-ray on a 3ft long cassette with patient standing upright with arms positioned in front with fingers along their clavicle and head facing forward
- A line has to be drawn from the center of C7 perpendicular to the horizontal border of the X-ray and extended toward the posterior superior aspect of S1 (the L5-S1 disc space)

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Measurement Criteria

- Positive Sagittal balance: If C7 plumb line falls more than 2cm anterior to the posterior L5-S1 space
- Negative Sagittal balance: If it falls 2cm behind

The normal is considered to be ± 2 cm from the posterior aspect of the L5-S1 disc space

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Normal Sagittal Plane Values

- Normal values
  - Cervical lordosis: 40° +/- 9.7°
  - Thoracic kyphosis: 20°- 50° (36°)
  - Lumbar lordosis: 31° - 79° (44°)

Values in parentheses from Bridwell & Bernhardt in normal volunteers

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Center of Gravity

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Uncompensated
Sagittal Alignment

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OR Positioning

Radiolucent frame which optimizes lordosis by extending hips

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How is Balance Maintained?

- Cervical lordosis, thoracic kyphosis, lumbar lordosis and sacral angulation have to neutralize each other (normal or congruent)
- Congruency enables head and trunk to line up directly over the pelvis
- This facilitates transfer of weight to femoral axis and maintenance of the center of gravity
- Essential for normal gait and posture

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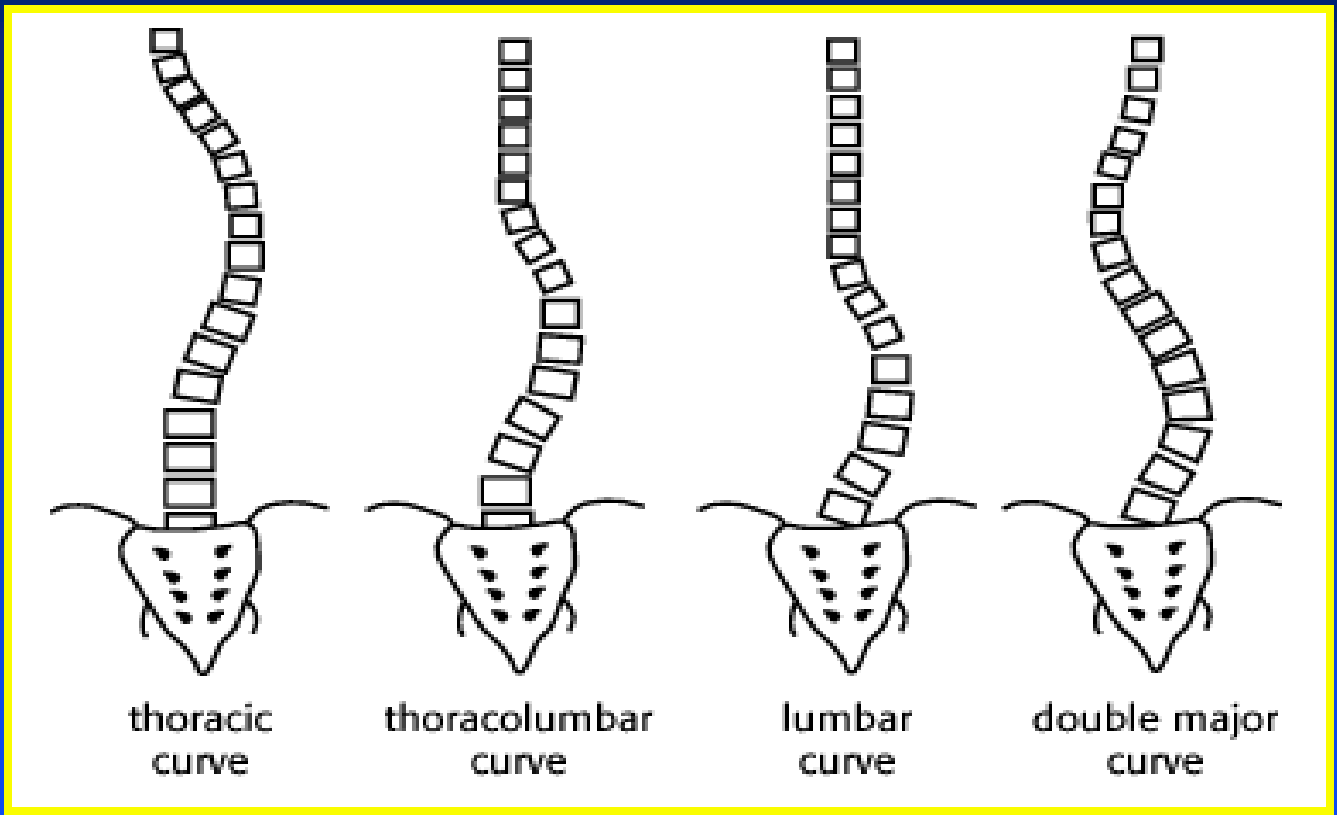
Types of curvatures

- Thoracic Curve
- Thoracolumbar Curve
- Lumbar Curve
- Double Major Curve



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Case Example

- 24 yo female grad student, diagnosis of scoliosis in 2000 at age 13 (AIS) – never wore brace
- No back pain or neurological symptoms
- Noticed clothes fitting differently and began to notice enlarging right posterior rib hump
- Had 5° curve progression over 1 year (38° --> 43°)
- Untreated progression of adolescent curve as a young adult

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Treatment

- Selective thoracic curve correction surgery
- Structural curve corrected (T4-L1)
- Compensatory curve not treated surgically
- Allow compensatory lumbar curve to correct over one year following correction of 1° curve

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Preop AP

Postop AP

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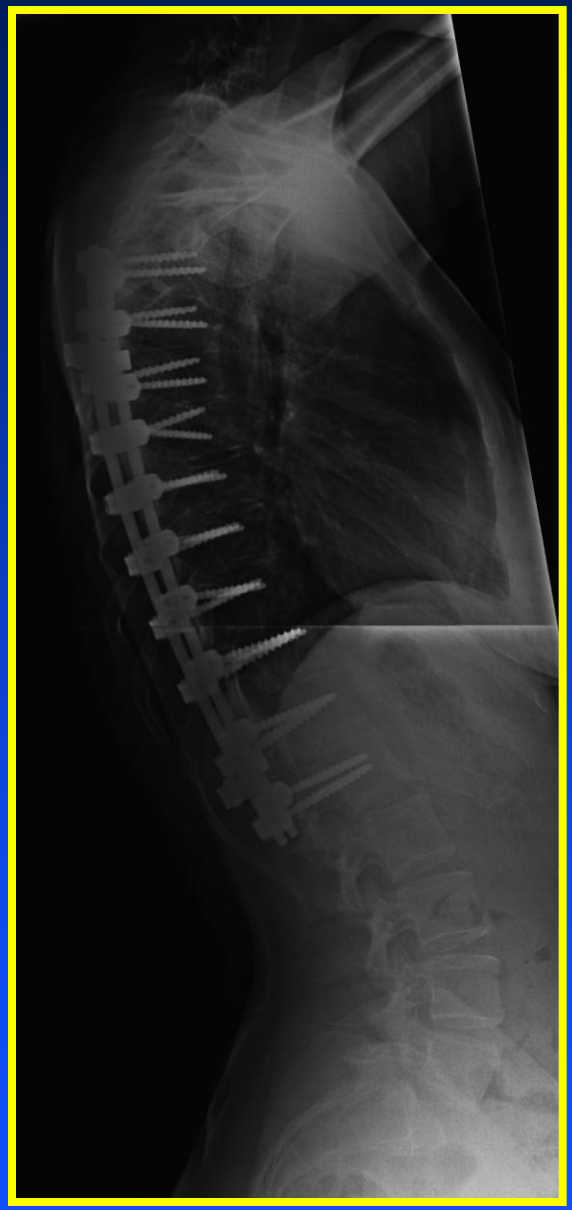
Preop Lat

Postop Lat



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Outcome

- Coronally & sagittally balanced
- Painfree & symptom free at 2 years postop
- Can touch toes
- Works out regularly in gym
- Pilates and yoga enthusiast

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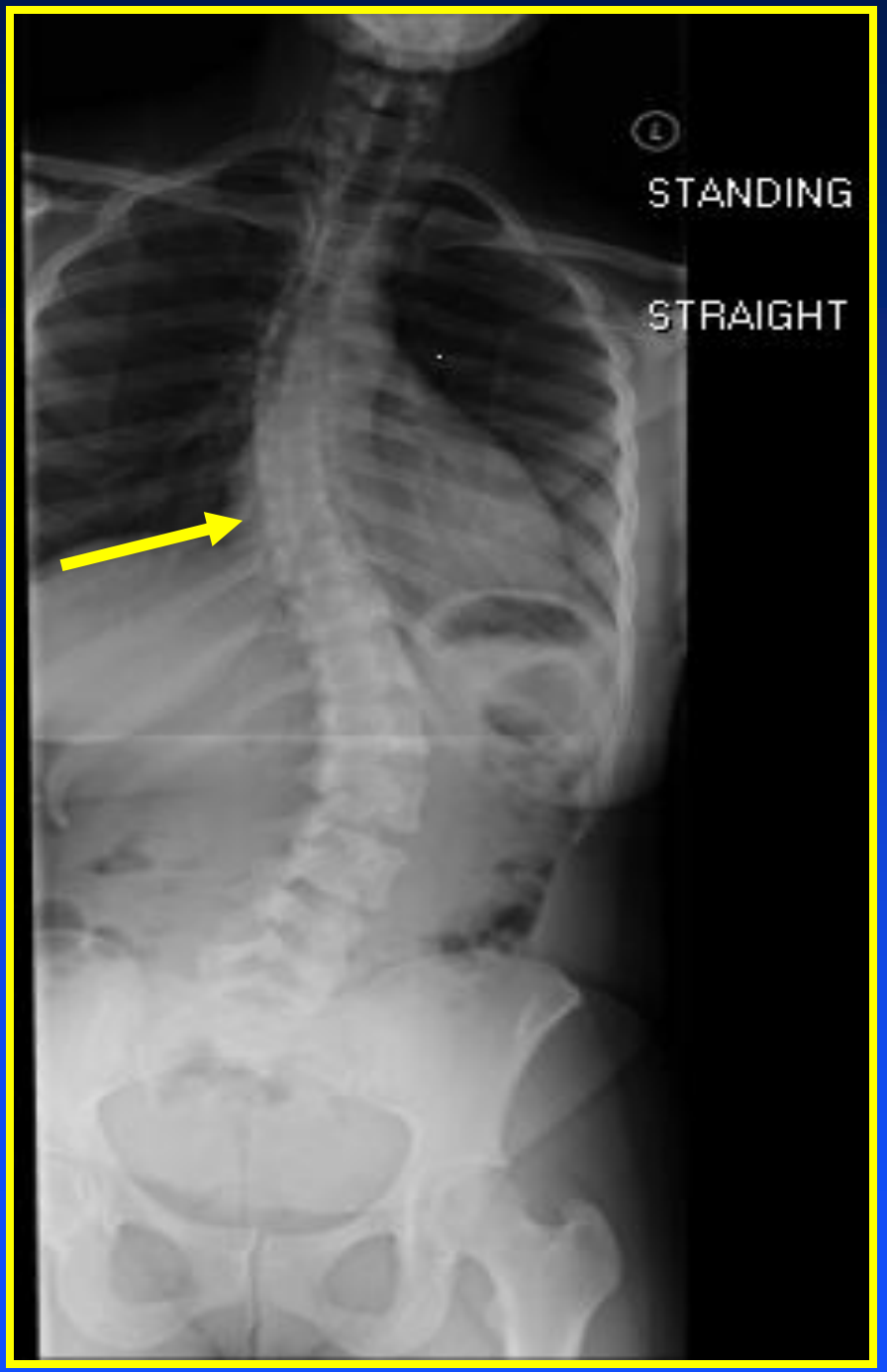
Neutral Vertebra

The first vertebra in a curve where the pedicles are equally visualized, no rotation is present in the neutral vertebra



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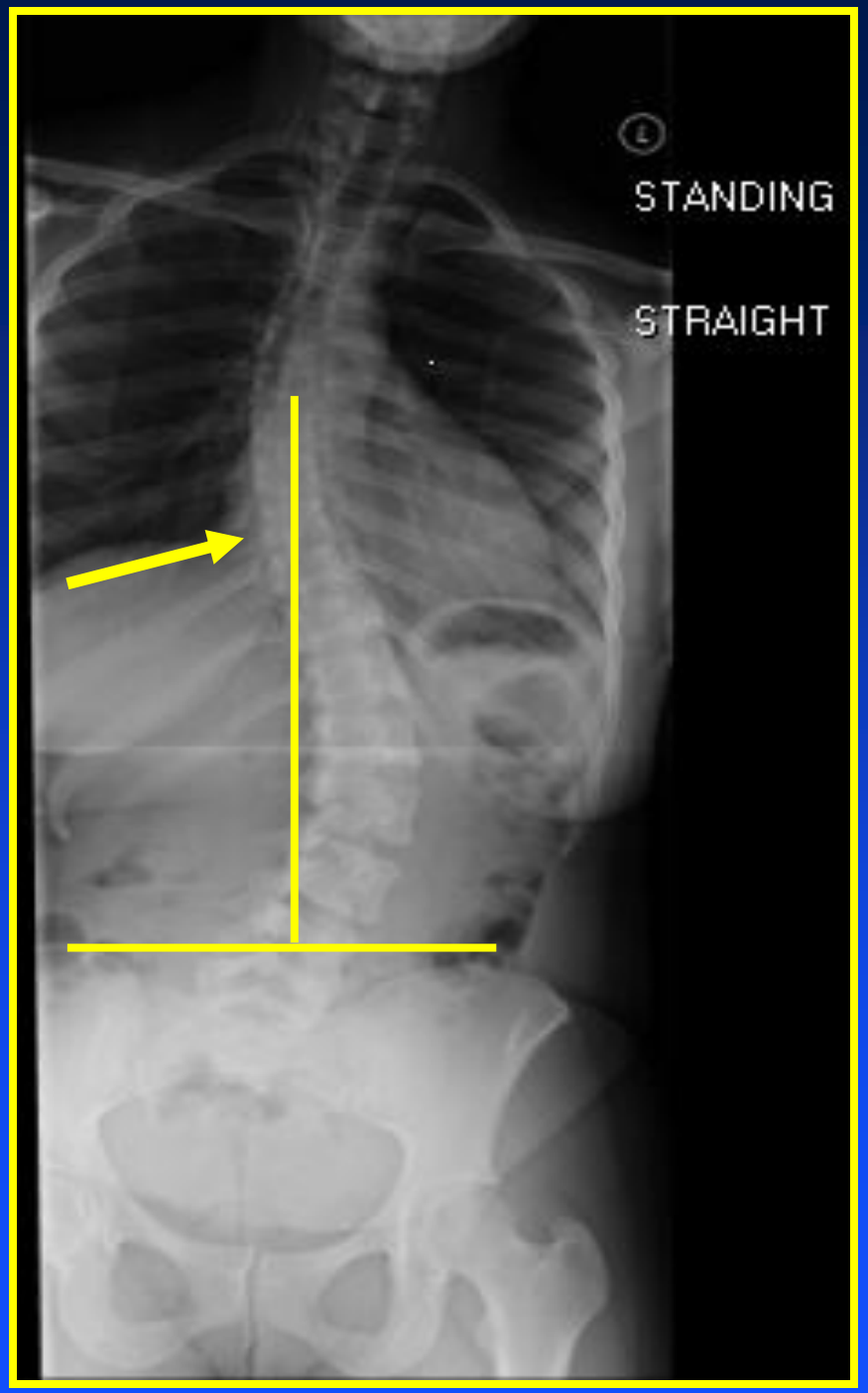
Stable Vertebra

The first vertebra in a curve which is bisected by the central sacral vertical line (CSVL)



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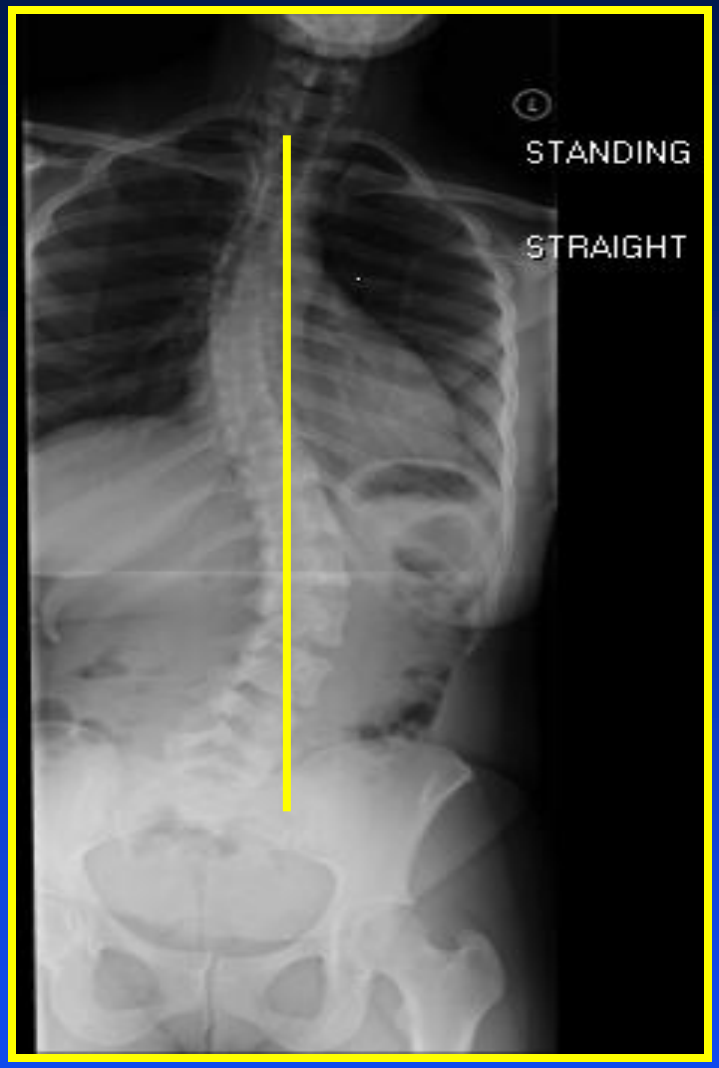
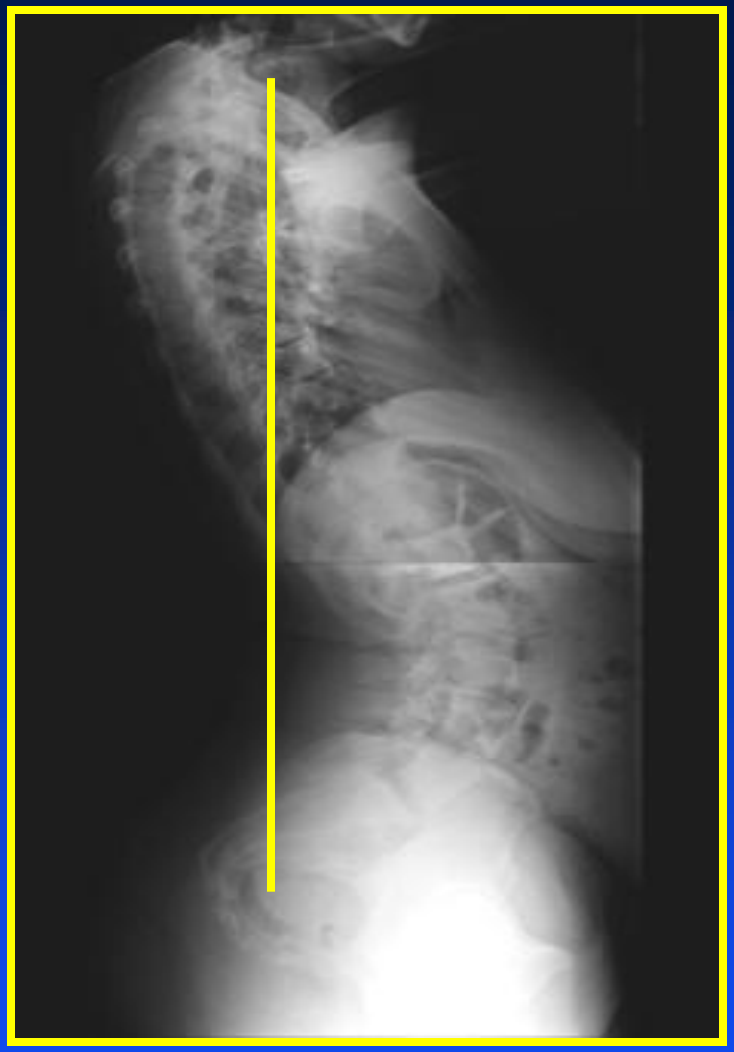


Coronal balance



Sagittal balance

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Cobb angles

Negative balance

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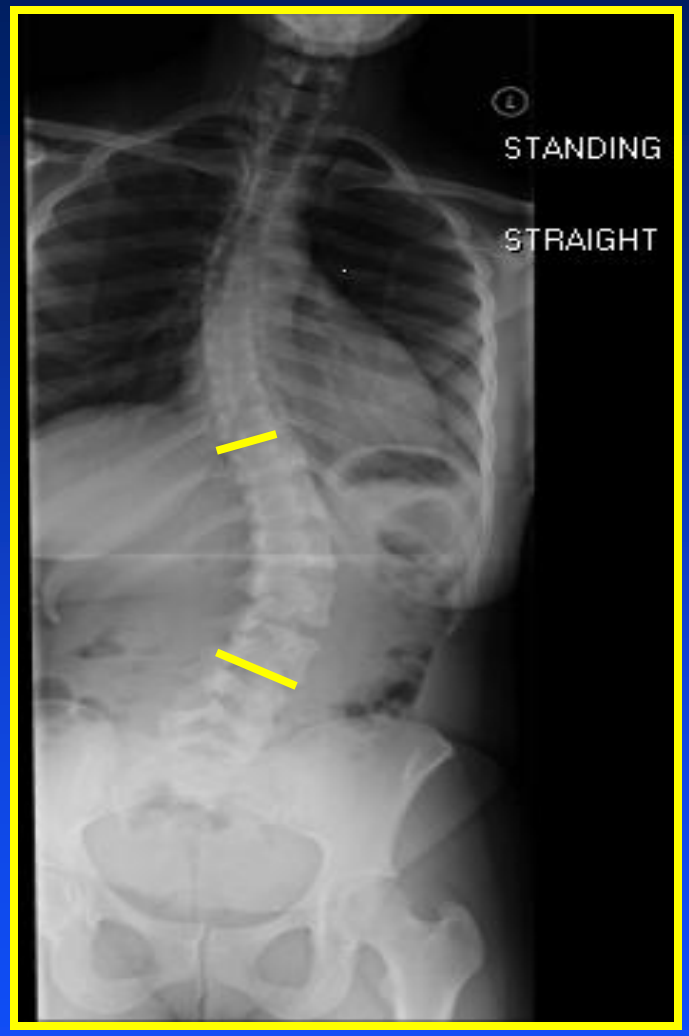
Cobb Angle Measurements



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Medical Fitness?

- Is the patient adequately fit to undergo a major deformity surgery procedure?

  Systems which need to be thoroughly assessed:

  -Cardiac

  -Pulmonary

  -Renal

  -Endocrine

  -Nutrition

  -Systemic diseases

  Is the patient a smoker?

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Dual Energy X-Ray Absorptiometry (DEXA or DXA)

- Measures bone density (BMD)
- T-score - compare values with "normal 30 year old" (best used for adults)
- Z-score - compare values with age and gender matched controls (best used for children)
- 1/10 the radiation dose of routine CXR

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Dual Energy X-Ray Absorptiometry (DEXA or DXA)

- World Health Organization (WHO)
- Sets standards for assessment of BMD
- Uses T-score values:

> -0.9	normal
-1.0 <--> -2.4	osteopenia
< -2.5	osteoporosis

- Do not use Z-scores for adults

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Smoking?

- Cigarettes
  - Clear correlation with fusion rates
  - Increased wound healing problems
  - Increased difficulties with ventilator
  - Effects on bone density
- Cigars
  - Effects are not clearly documented

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Expectations?

- Appearance
- Pain
- Function

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Expectations?

- Appearance
  - Adolescents
    - Improved body image
    - Tend to be realistic
  - Adults
    - Improved body image
    - Tend to be unrealistic

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Expectations?

- Pain
  - Adolescents
    - Usually do not have pain
  - Adults
    - Usually have pain
      - Radicular
      - Back
    - Usually progressively worsening

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Expectations?

- Function
  - Adolescents
    - Usually normal
  - Adults
    - Usually limited
    - Usually progressively worsening

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Expectations?

- Factors that affect expectations:
  - Patient expectations
  - Surgeon expectations
  - Must attempt to be realistic
  - Must spend time with patient and family to clarify this issue
  - Address appearance, pain, and function in a realistic fashion

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Expectations?

- Realistic concepts:
  Medical fitness
  Neurological condition
  Bone quality

- Sometimes small surgery is preferable due to medical concerns

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Case Example

- 15 yo female with diagnosis of scoliosis in 2005 discovered during routine screening.
- 5 feet ½ inch and 108lbs
- No symptoms from scoliosis
- Active on the track team
- No complaints of ‘crookedness’
- No back pain or neurological symptoms
- Menses began in 4/06

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History

- Pt treated in past with:
  - Physical Therapy
  - Home Exercising
  - No bracing performed
  - Jewett Brace prescribed but never used
- No meds, NKDA, No Drugs, Tobacco, EtOH
- No medical Hx or past surgeries

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Physical Exam

- Motor 5/5 B/L throughout LE
- Sensory completely intact throughout
- Reflexes 2+ throughout
- Fluid gait
- All other exams within normal limits

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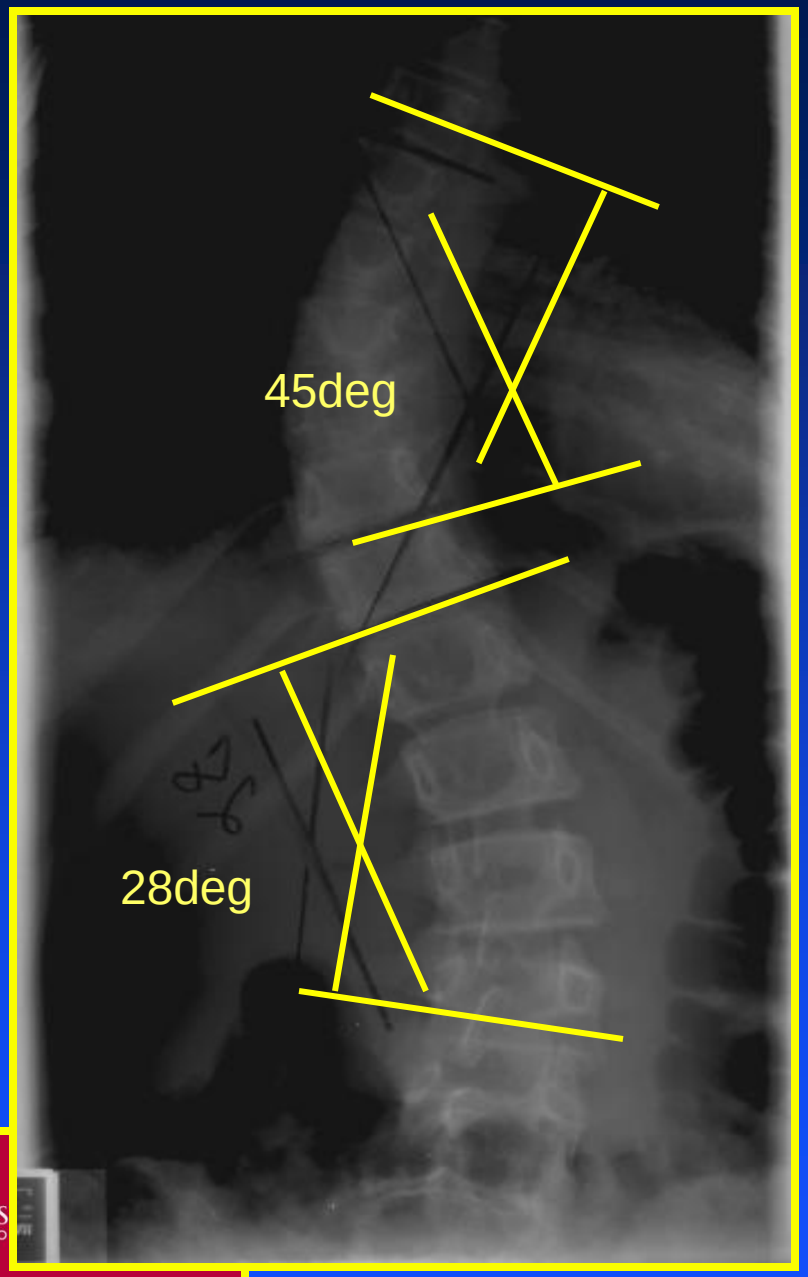

Measurements

Jun 27, 2005

- T5-T11 = 45°
- T11-L3 = 28°

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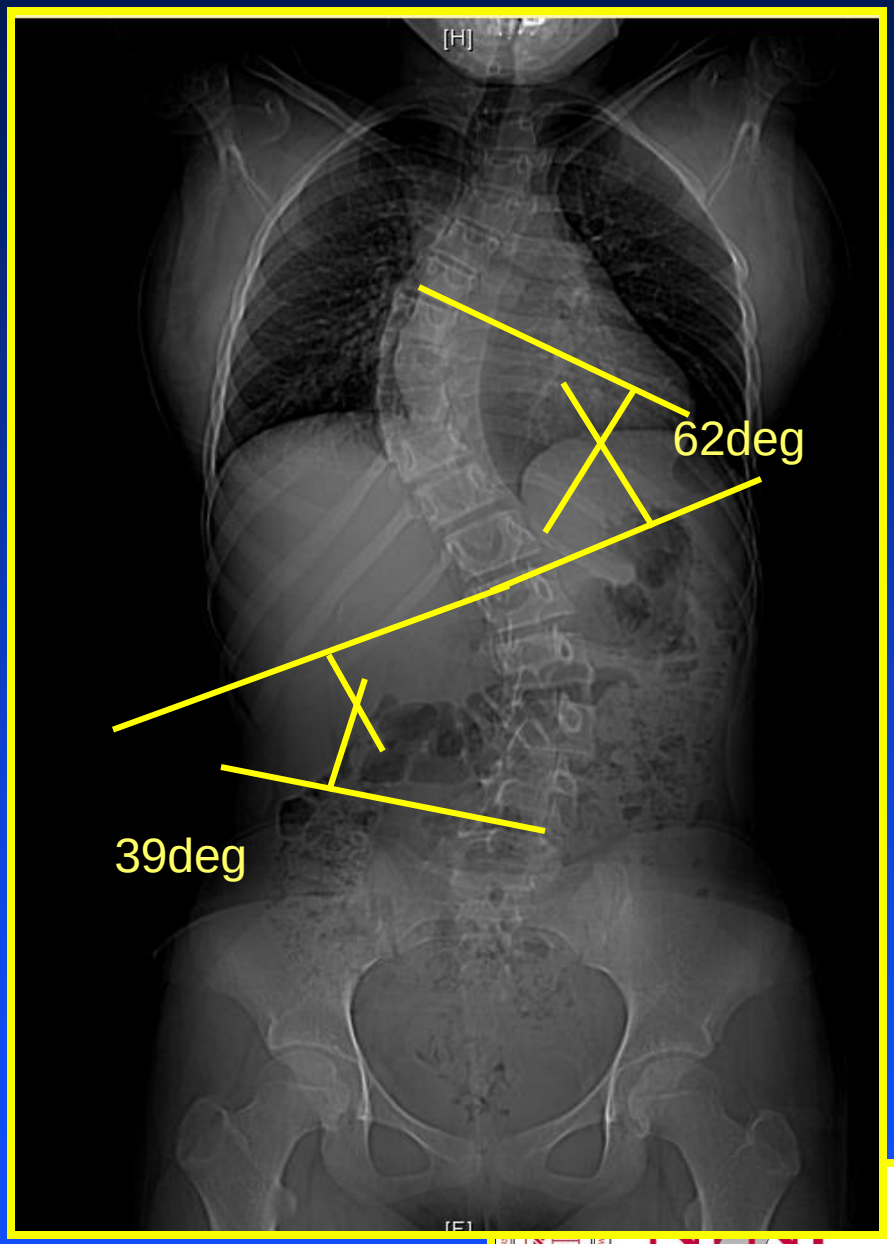
Measurements
May 23, 2007

- T5-T11 = 62˚
- T11-L3 = 39˚
- Sagittal alignment +2.6cm
- R shoulder 1.5cm below L
- Plumb line C7 to gluteal 2cm L of midline
- Iliac crests are at equal height



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3D Imaging

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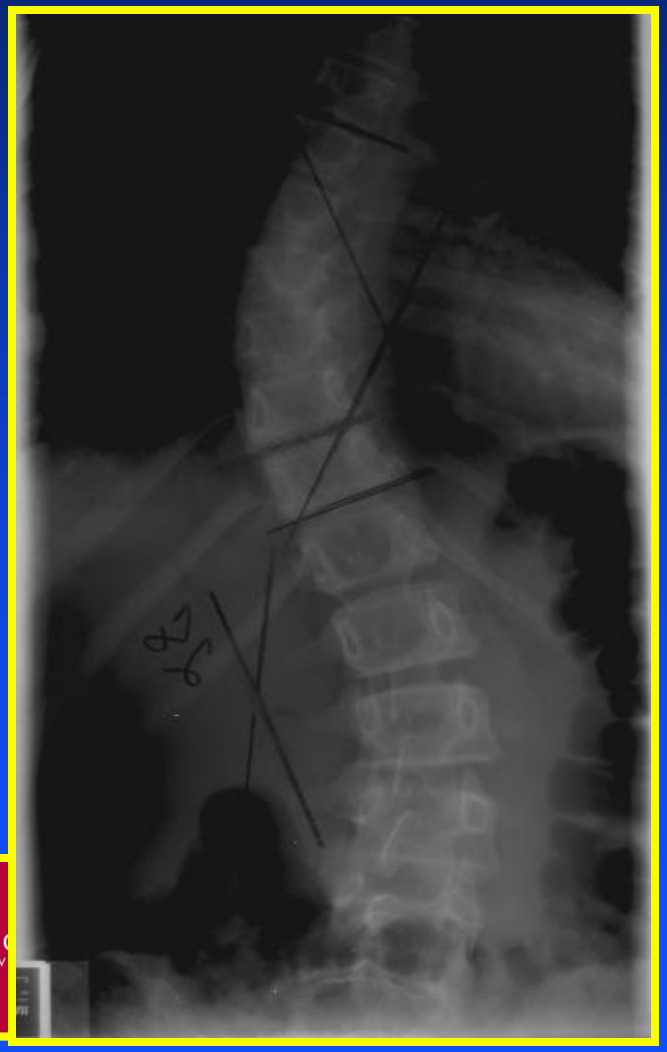
June 27, 2005

T5-T11: 45˚

T11-L3: 28˚



May 23, 2007

T5-T11: 62˚

T11-L3: 39˚

July 9, 2007

- Scoliosis series (preop)

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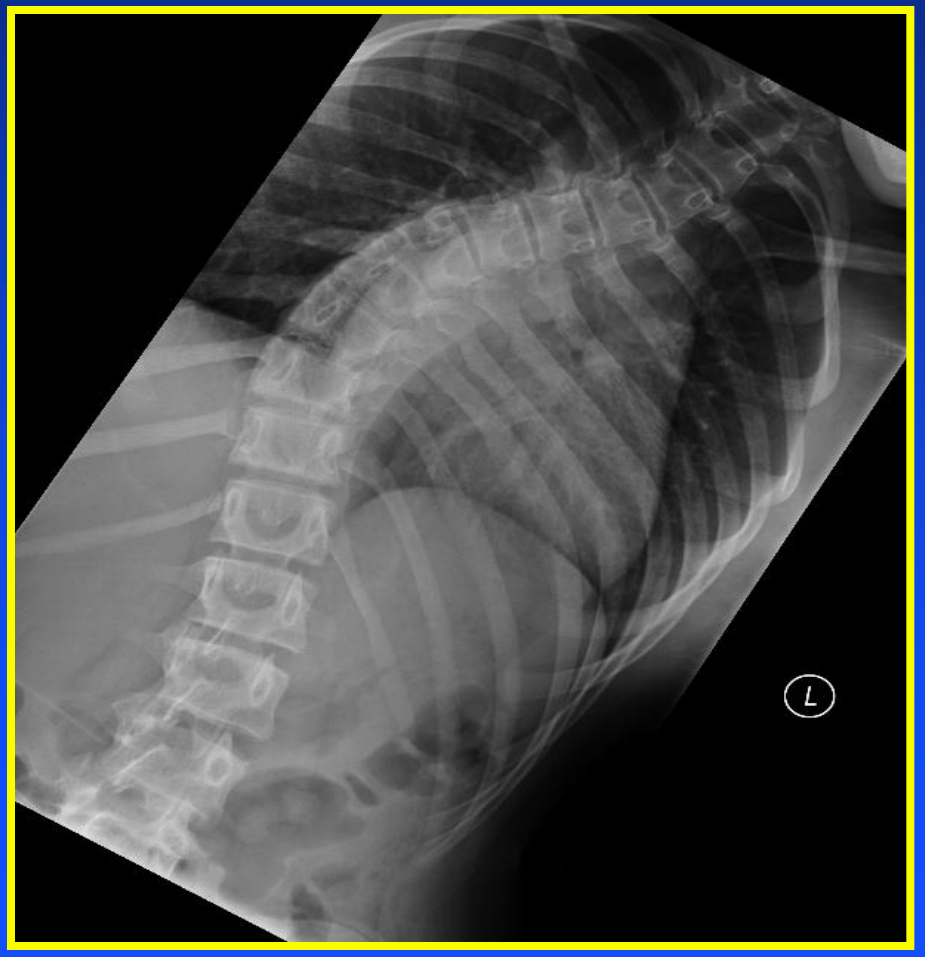
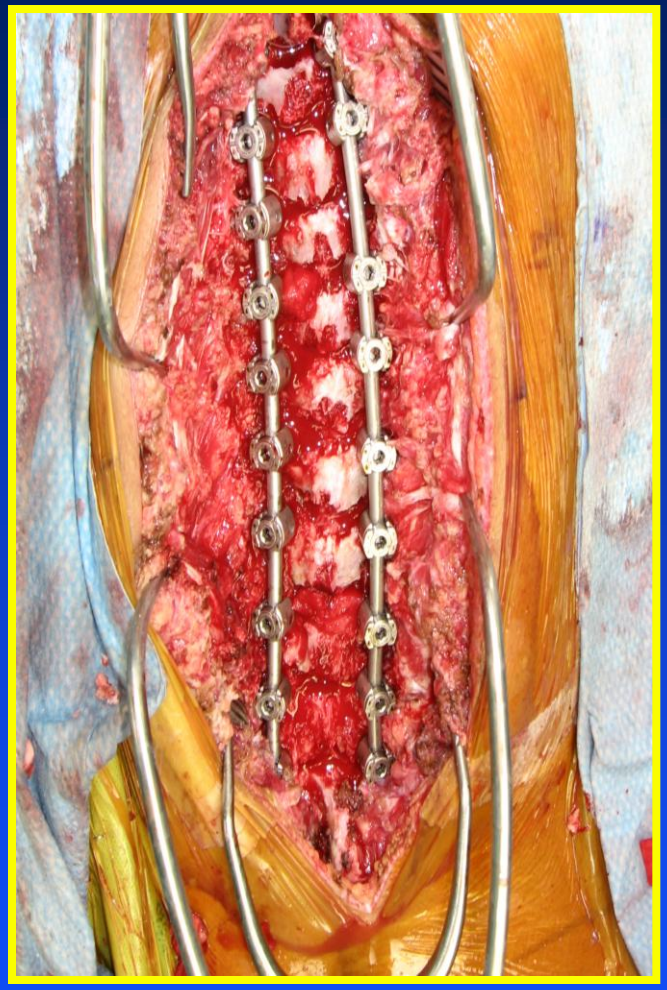
Bending Films

R bend - thoracic curve corrects

L bend - lumbar curve corrects



Intra Op – Before and After



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Before and After

Preop Height:

5’ ½”

Preop Angles:

T5-T11 = 62°

T11-L3 = 39°

Postop Height:

5’ 4”

Postop Angles:

T5-T11 = 13°

T11-L3 = 22°

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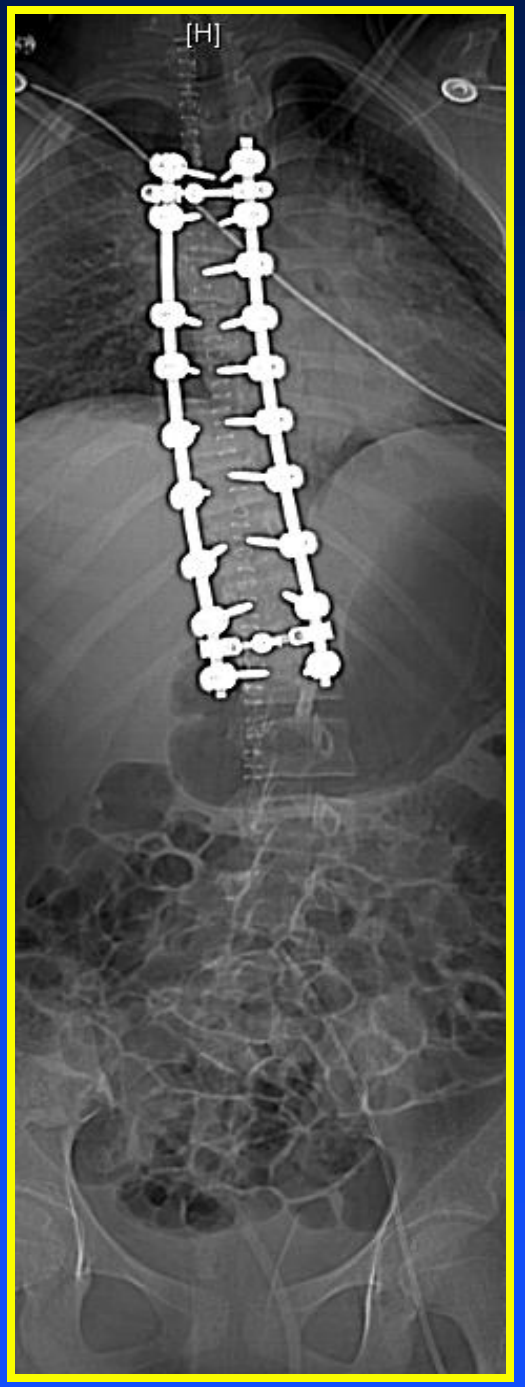
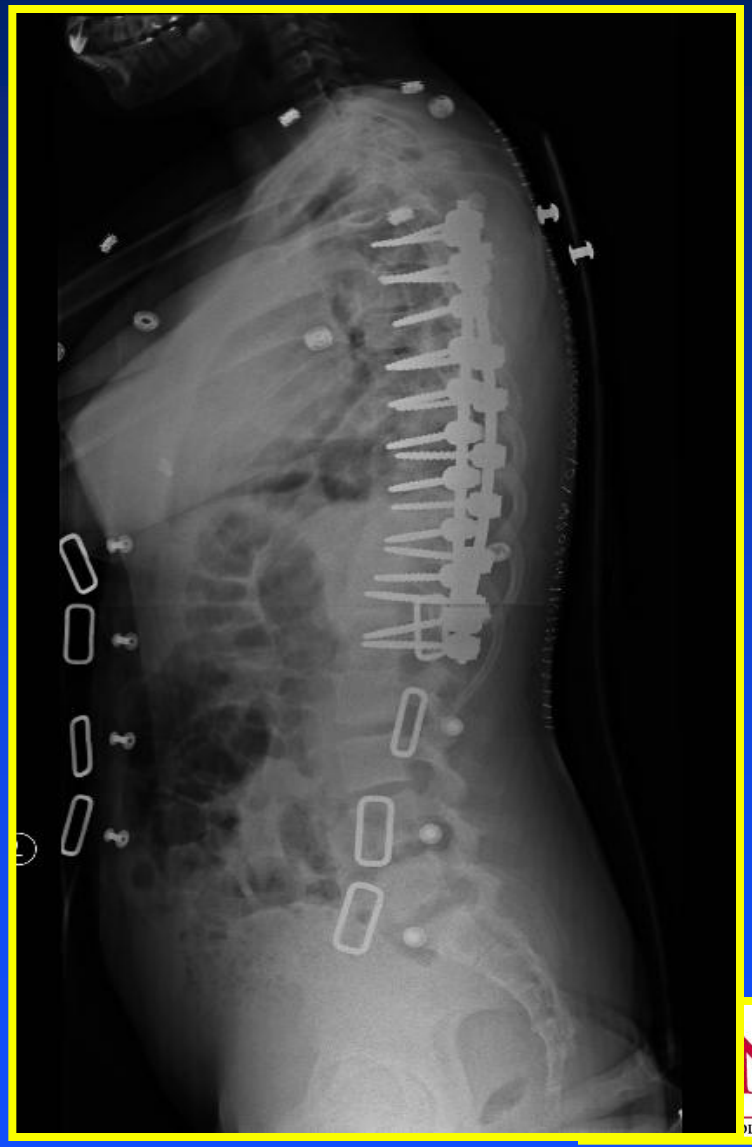


Before and After



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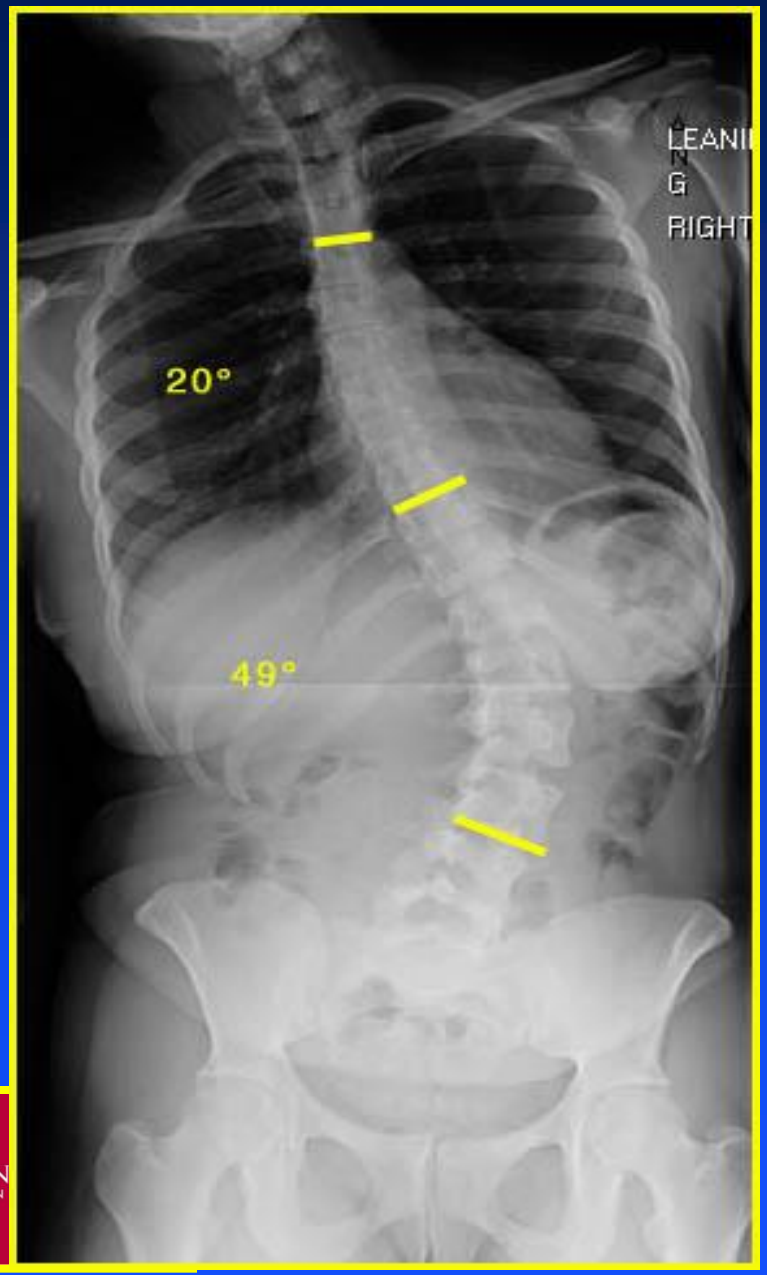
Bending Views demonstrate flexibility



Correction Achieved

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Sagittal Balance maintained

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Conclusions

- Some patients are not fit for major deformity surgery
- In those patients, either a smaller, decompressive surgery or no surgery may be the better choice
- Attempt to improve the patient's fitness before rushing to surgery (i.e. quit smoking, lose weight, correct bone density, etc.)

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Thank You