Spinal deformity corrections: The State of the Art

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Spinal deformities

- Children — early onset; congenital
- Teenagers (AIS) — adolescent idiopathic
- Adults & elderly (ASD) — adult spinal deformity

Early onset scoliosis

- 2 – 12
- B > G
- L > R
- Resolving v progressive

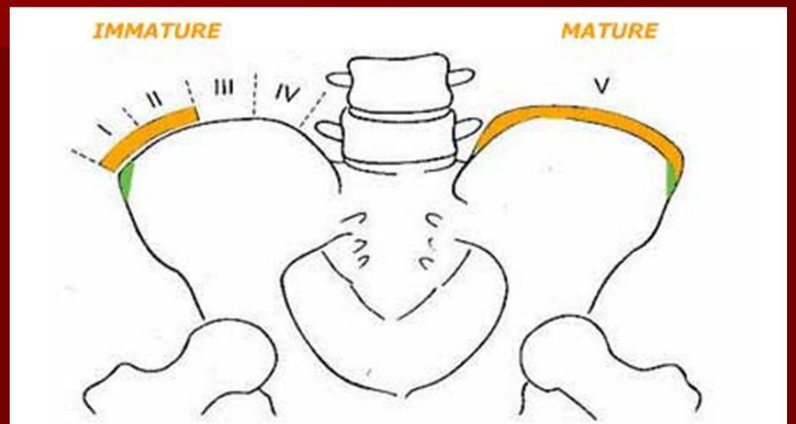
Early onset scoliosis

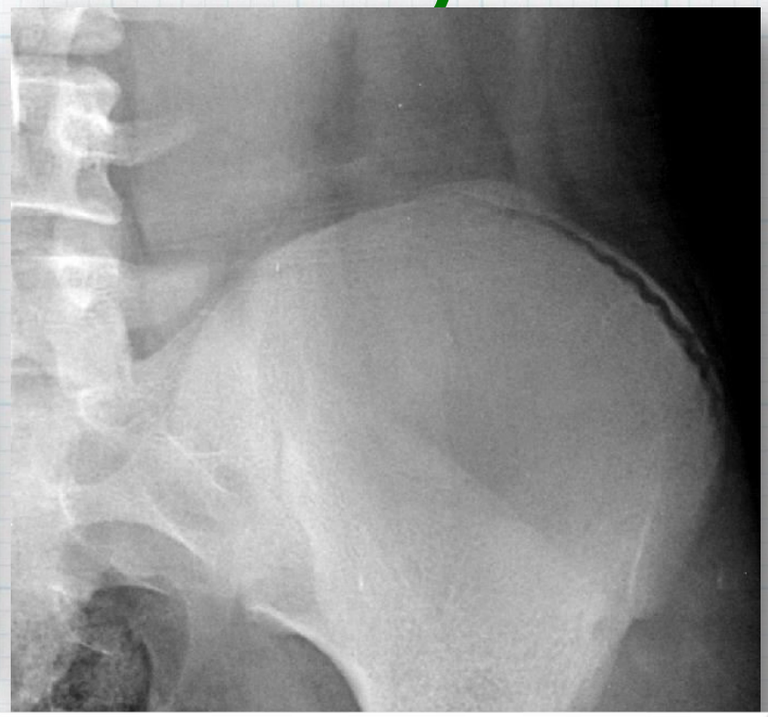
- Skeletal maturity indicators
- Trunk growth
- MAGEC v TGR
- VEPTR
- Shilla and Tethering

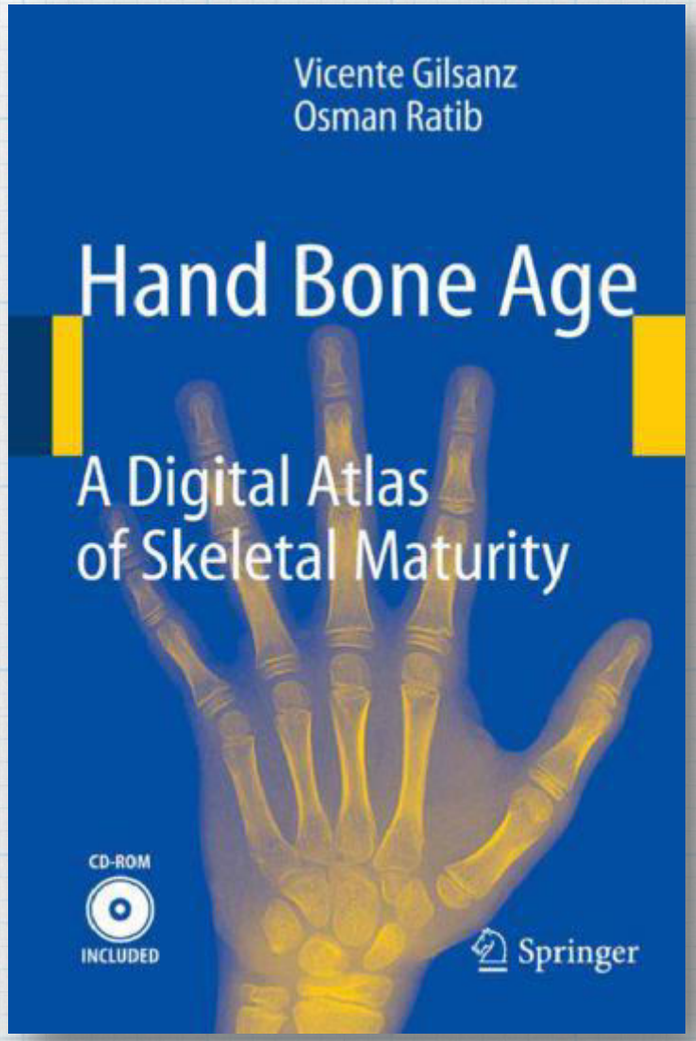
EOS:

skeletal maturity indicators

Risser sign







Girls		Boys	
Risser	**Age**	**Risser**	**Age**
1	13.8	1	15.2
2	14.3	2	15.2
3	14.7	3	16.3
4	16.0	4	16.3
5	16.11	5	18.0

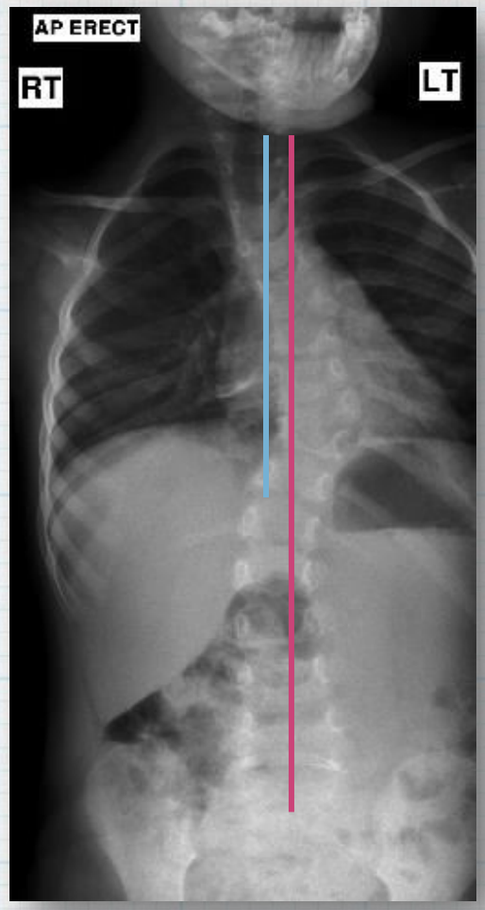
Early onset scoliosis:

trunk growth

- Lung growth: first decade is ‘golden period’
- Thoracic volume: T1 – T12; T1 – S1 (sitting height)
- Spinal deformity: Cobb angle

EOS:

assessing the magnitude



Lung function

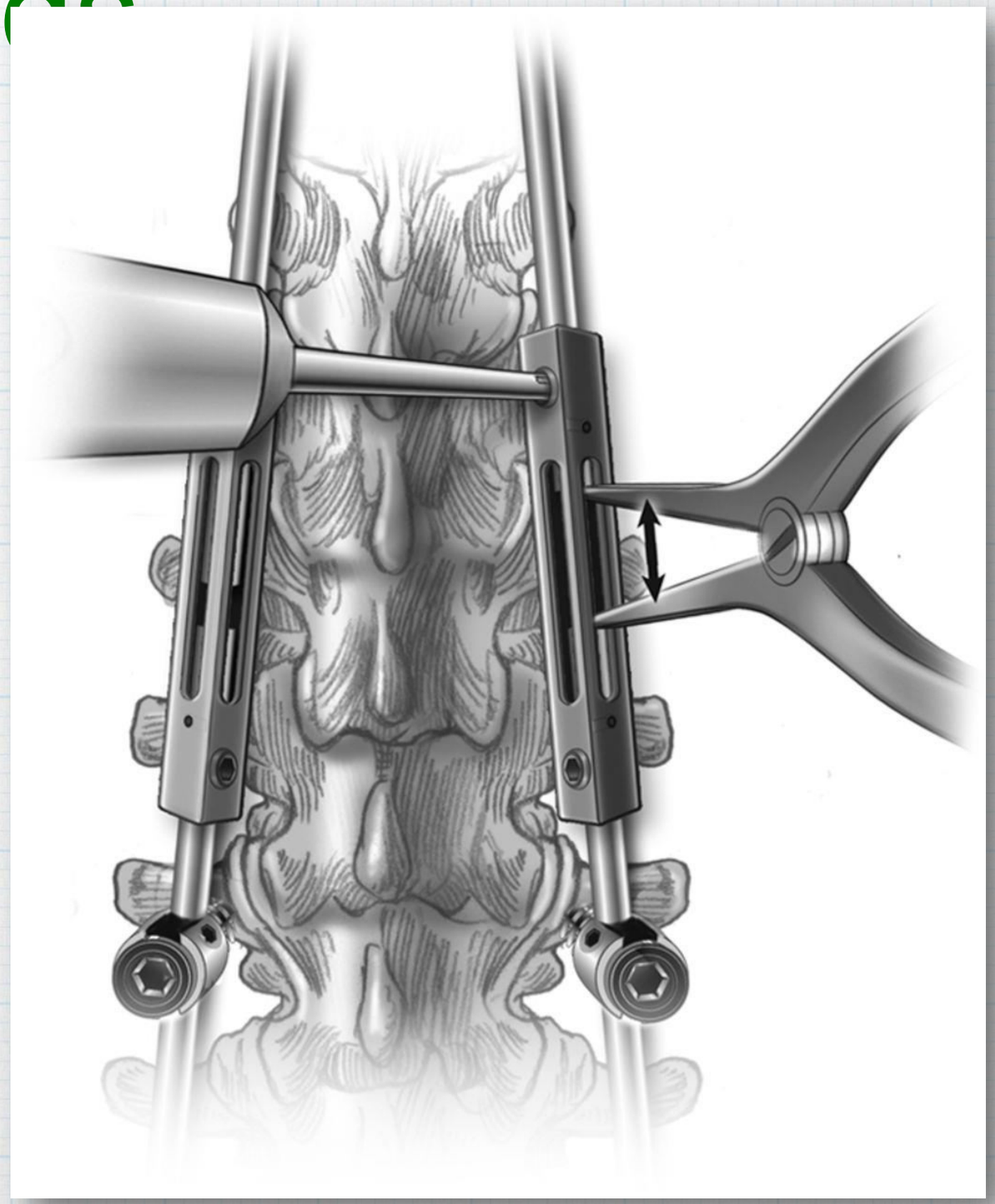
* Thoracic volume
* Spirometry
* Oximetry
* Chest wall compliance

T1 – T12: Thoracic height
T1 – S1: Sitting height

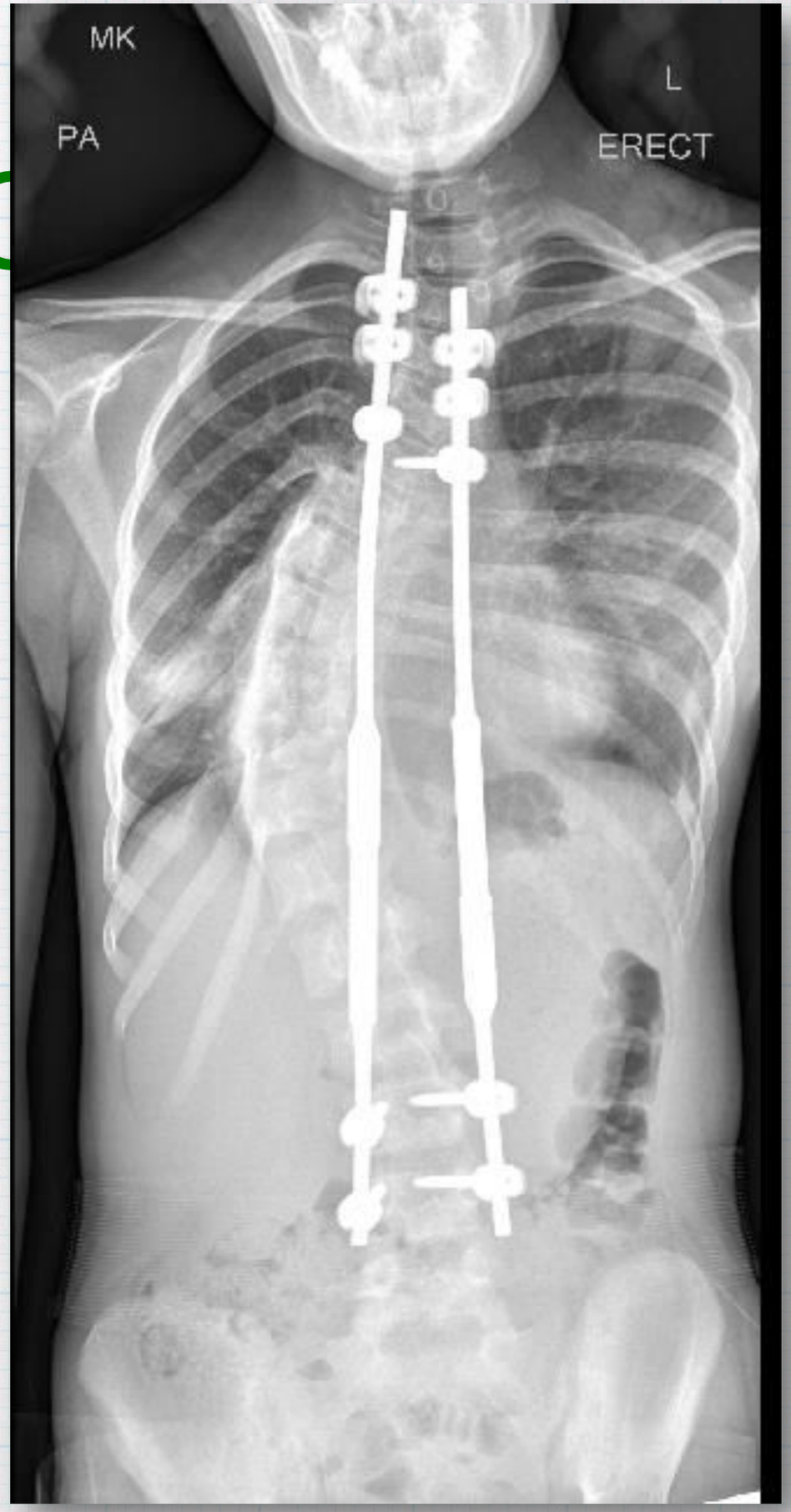
	Boys		Girls	
	T1 – T12	*T1 – S1*	*T1 – T12*	*T1 – S1*
Newborn	11	18.5	11	18.5
Child	18	28.5	18	28.5
Young	22	34.5	22	34.5
Adult	28	44	26	41.5

EOS: traditional growing rods

- Surgical distraction
- 6 monthly operations
- ‘Traumatic’



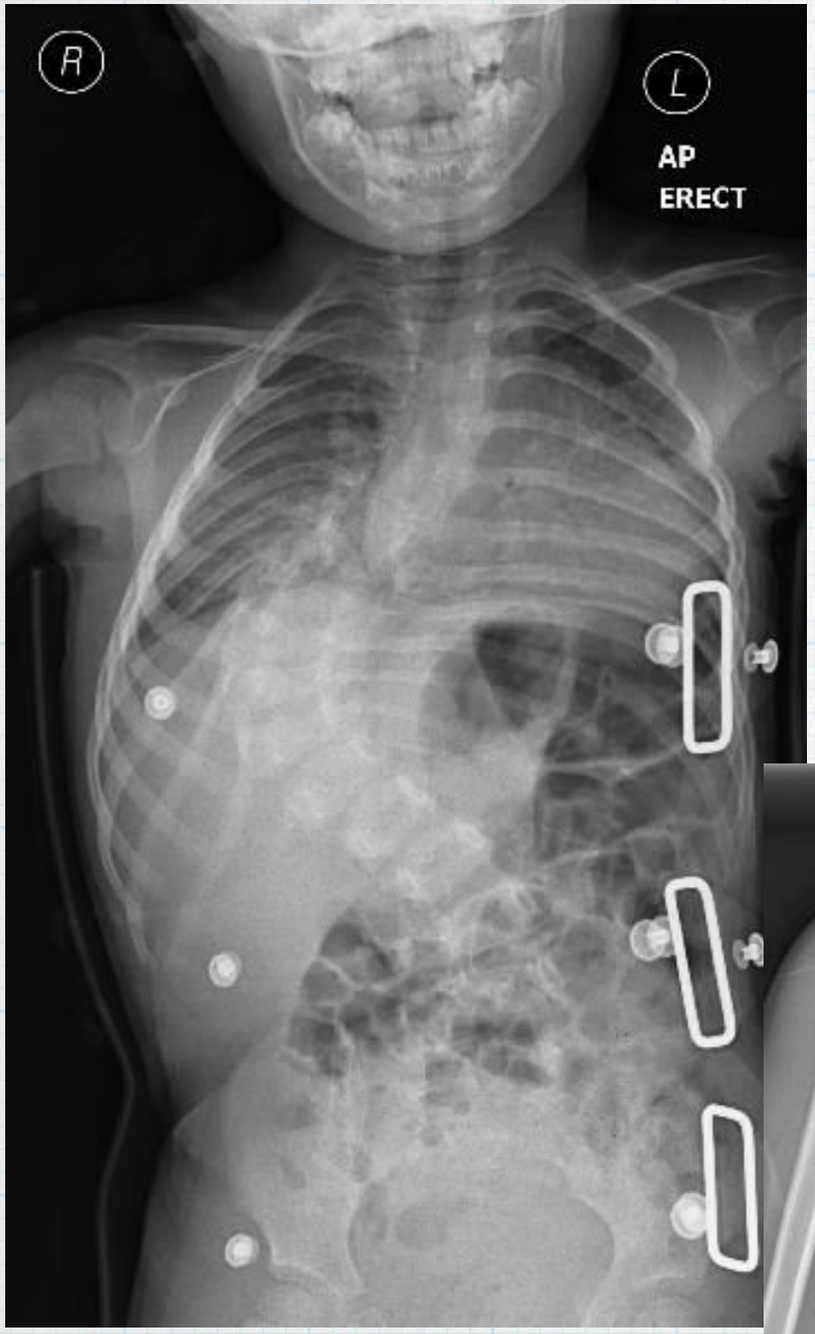
EOS: MAGEC



- Magnetically controlled actuator
- MAGnetic Expansion Control system
- Fewer operations and anaesthesia

EOS: MAGEC

* Out-patient distraction
* Patient friendly
* Cost (initial v recurring)

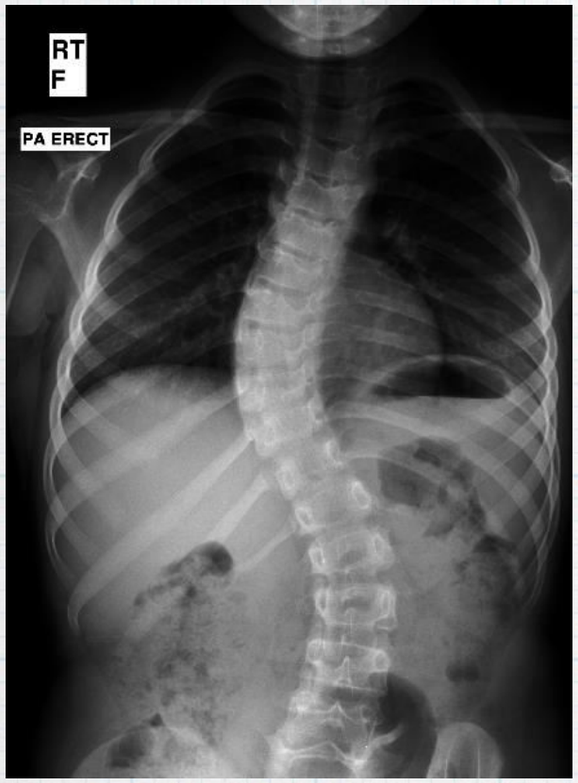


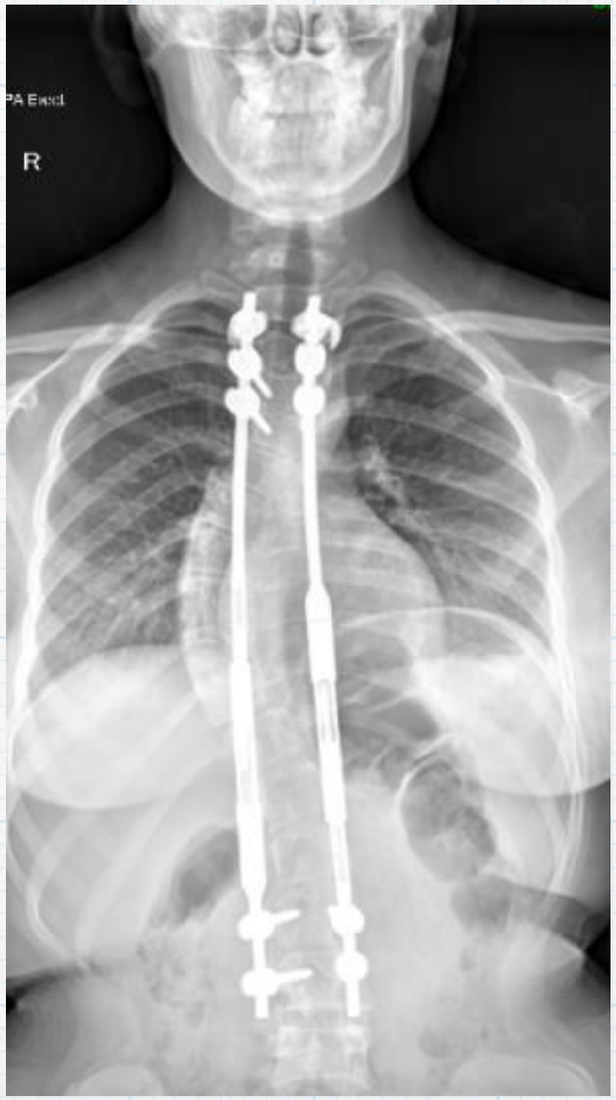
7 / F

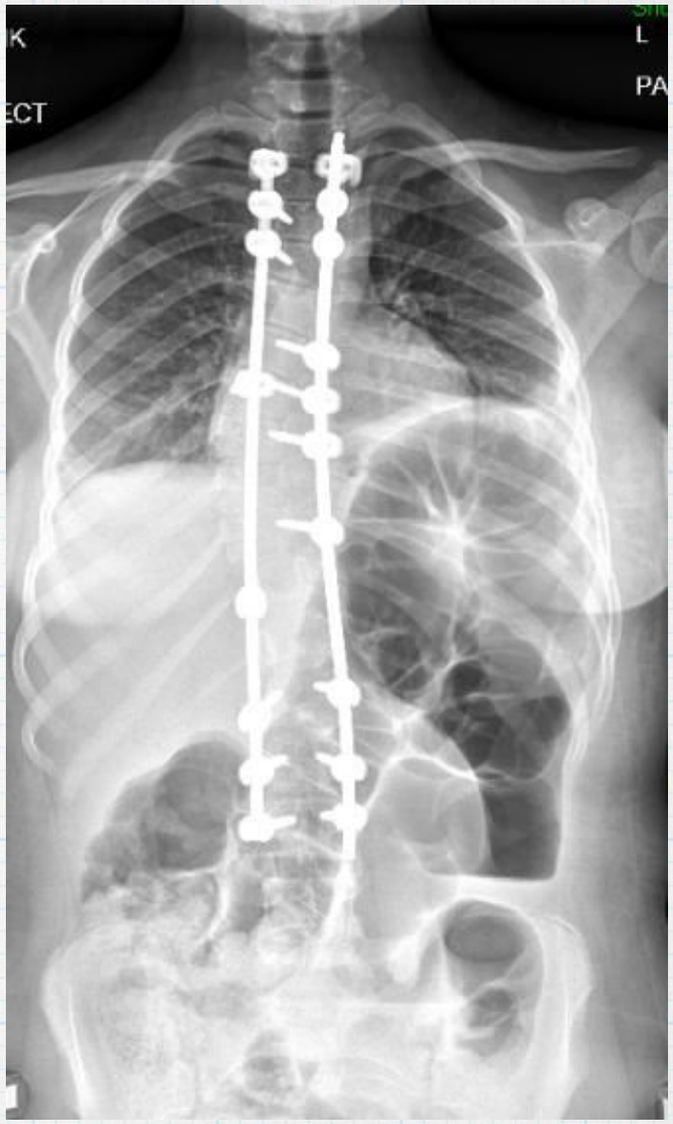
Cobb: 80º to 60º

T1 – S1: 21.8 to 29.5 cm

FU period: 2.5 years





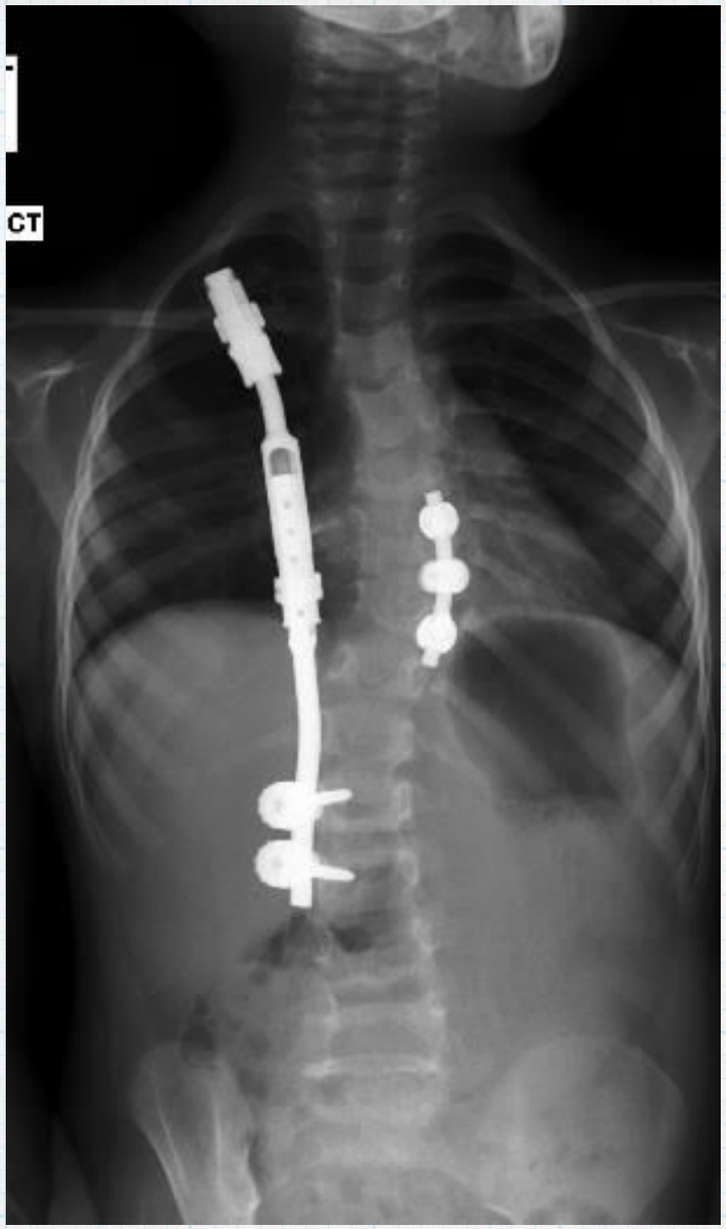


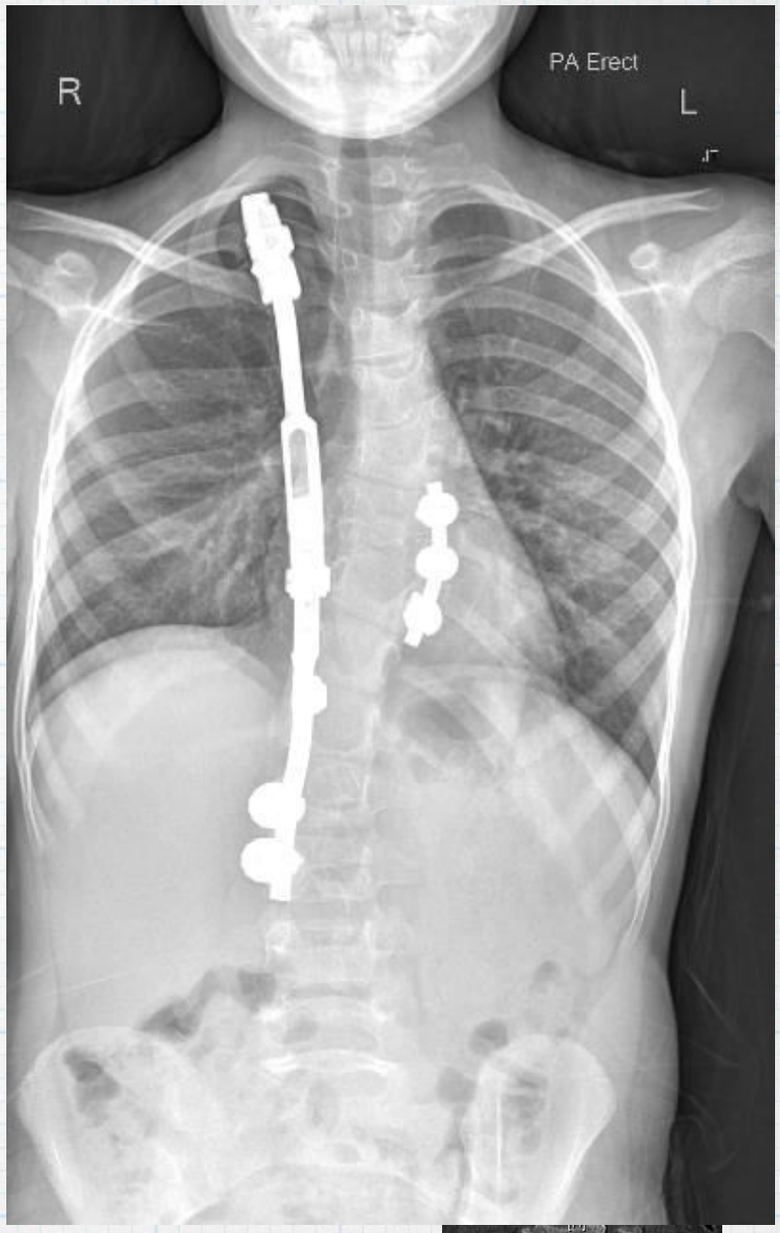
7 yrs	
Thoracic	46º
Lumbar	40º
T1 S1	27.7 cm

12 yrs	
Thoracic	25º
Lumbar	12º
T1 S1	31.2 cm

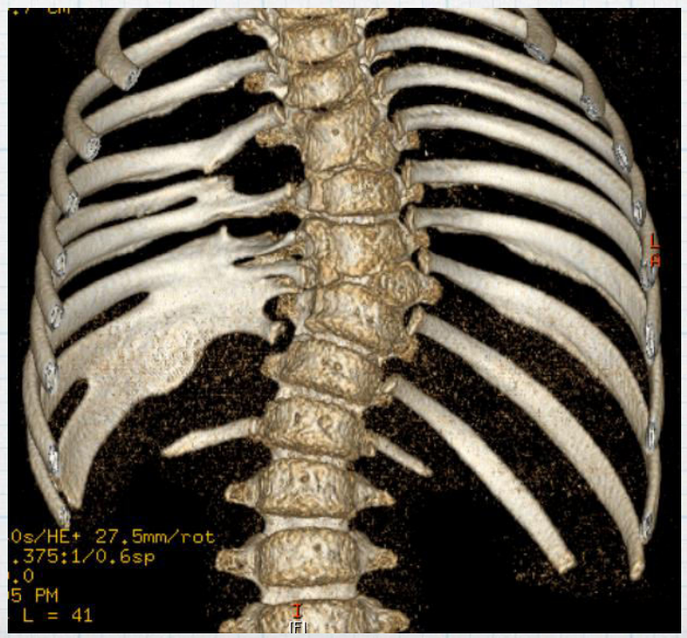
14 yrs	
Thoracic	42º
Lumbar	11º
T1 S1	38.9 cm

15 yrs	
Thoracic	21º
Lumbar	09º
T1 S1	38.6 cm





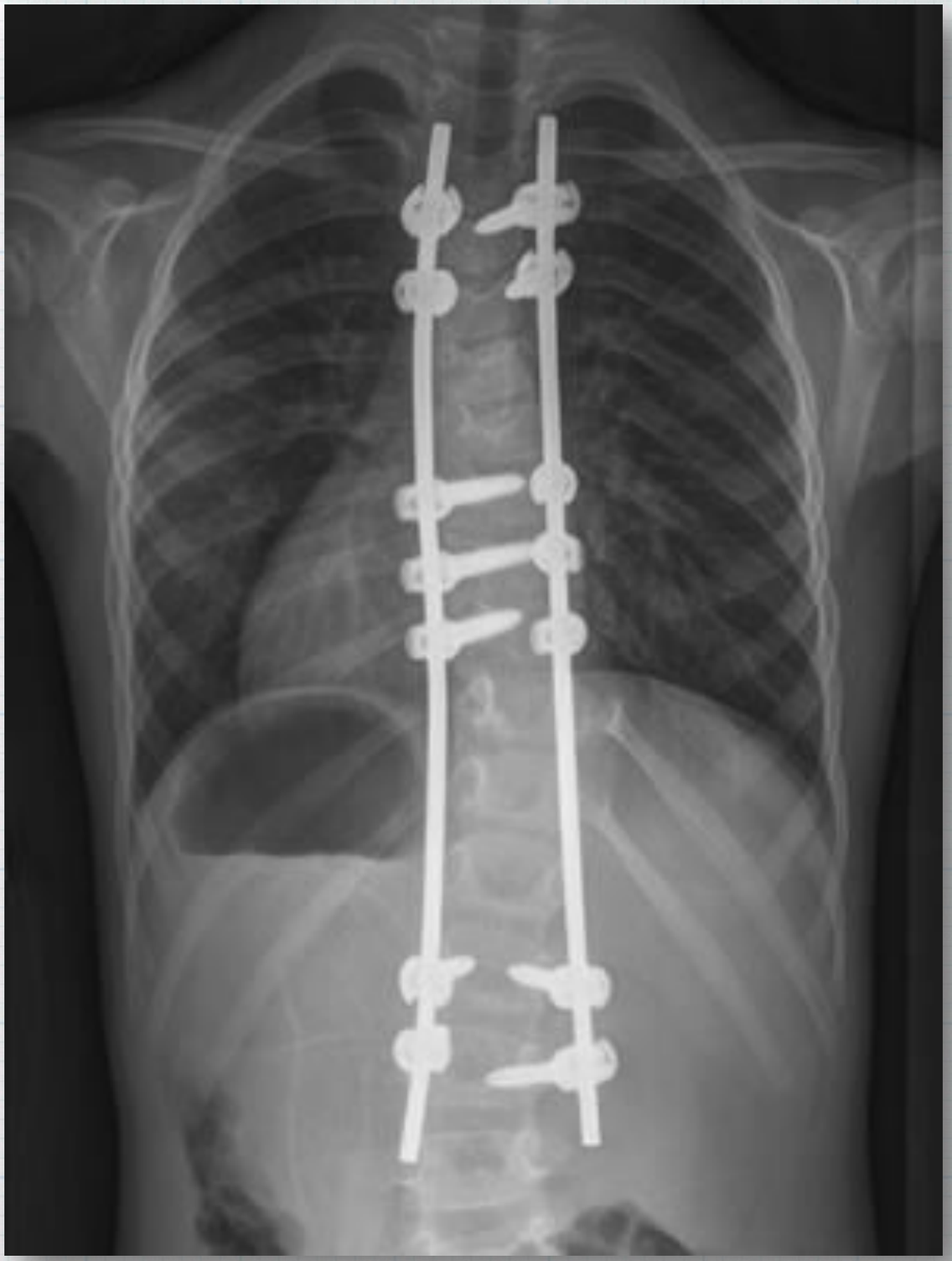
* T9 hemi-vertebra
* Convex growth arrest
* VEPTR



EOS: SHILLA

- Growth guidance system
- Fuse apex
- Growth at the ends

SHILLA screw



EOS: Vertebral body tethering

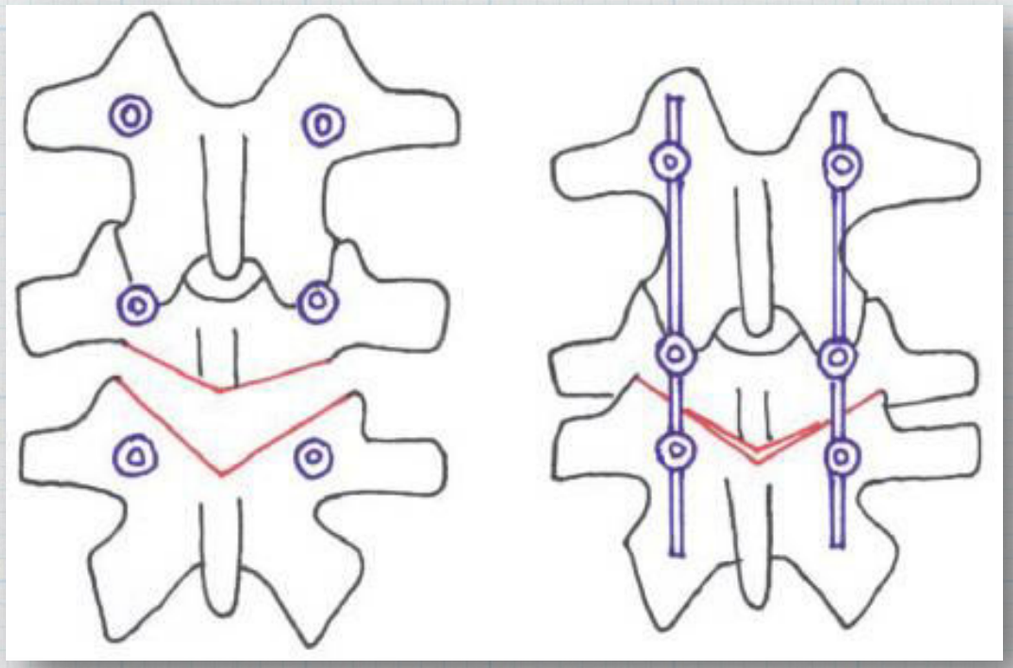
- New technology
- Not freely available

Adolescent idiopathic scoliosis

* Teenage girls
* MRI normal
* Progression linked with skeletal maturity
* Bracing of limited benefit

AIS: improving outcomes

- Better corrections
- Short fusions
- Releases
- Osteotomies



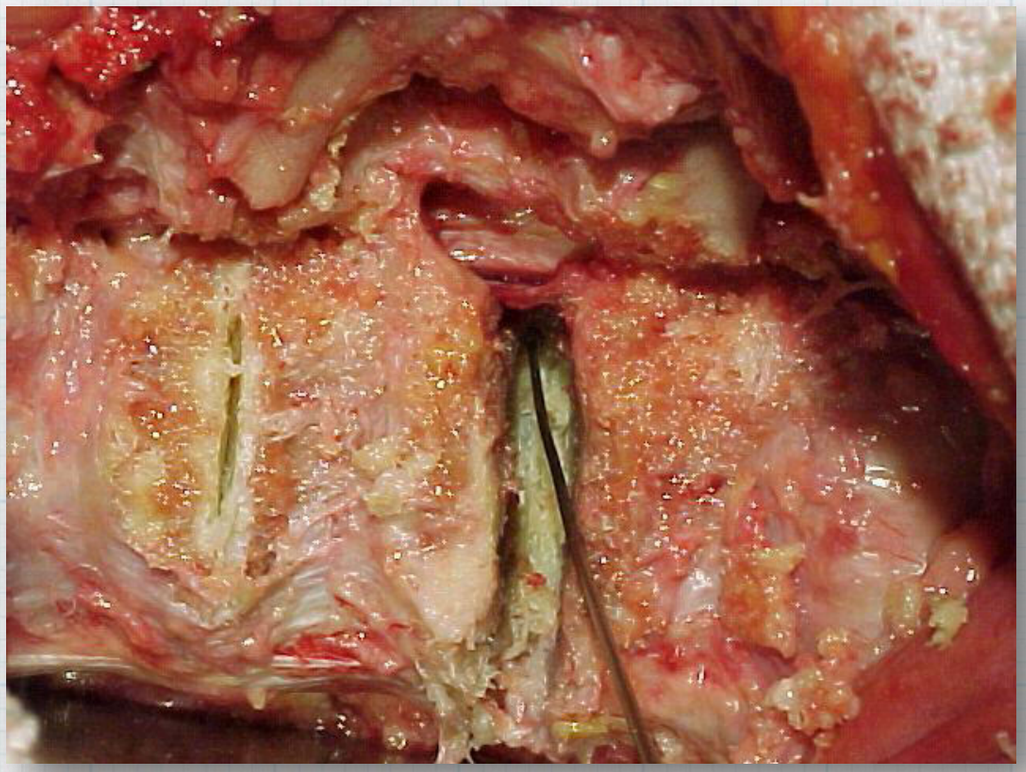
Cobb 77º to 18º

15 / F
Post menarche
2 years

Anterior release
5 levels

Posterior correction
4 osteotomies
T3 to L3

Anterior corrections



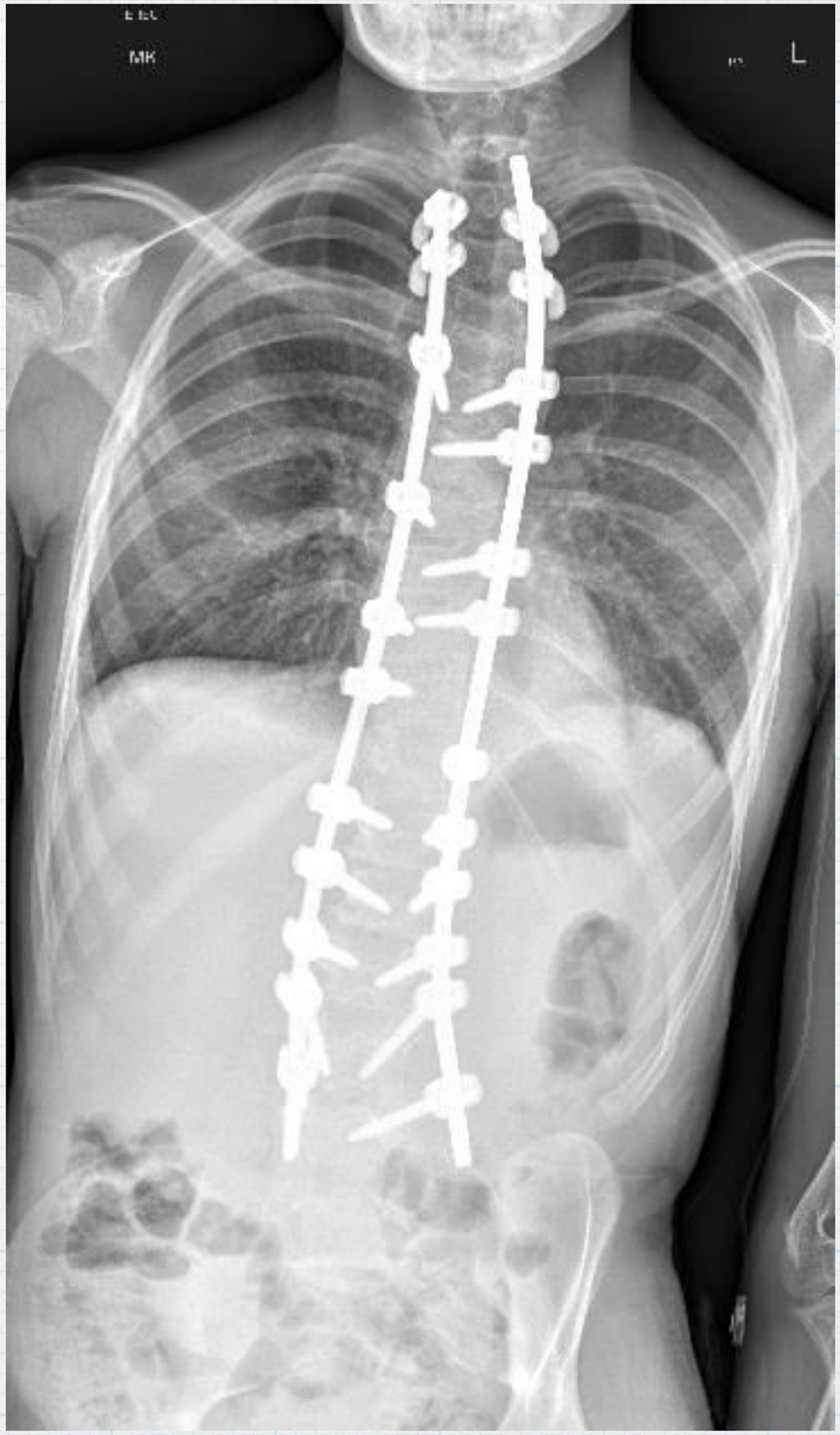
16 / M

Posterior correction T3 to L4

Thoracic 55° to 18°

Lumbar 69° to 19°

Rib hump improved



14 / M

Anterior release 4 levels + Posterior correction T3 to L4

Thoraco-lumbar 78º to 05º

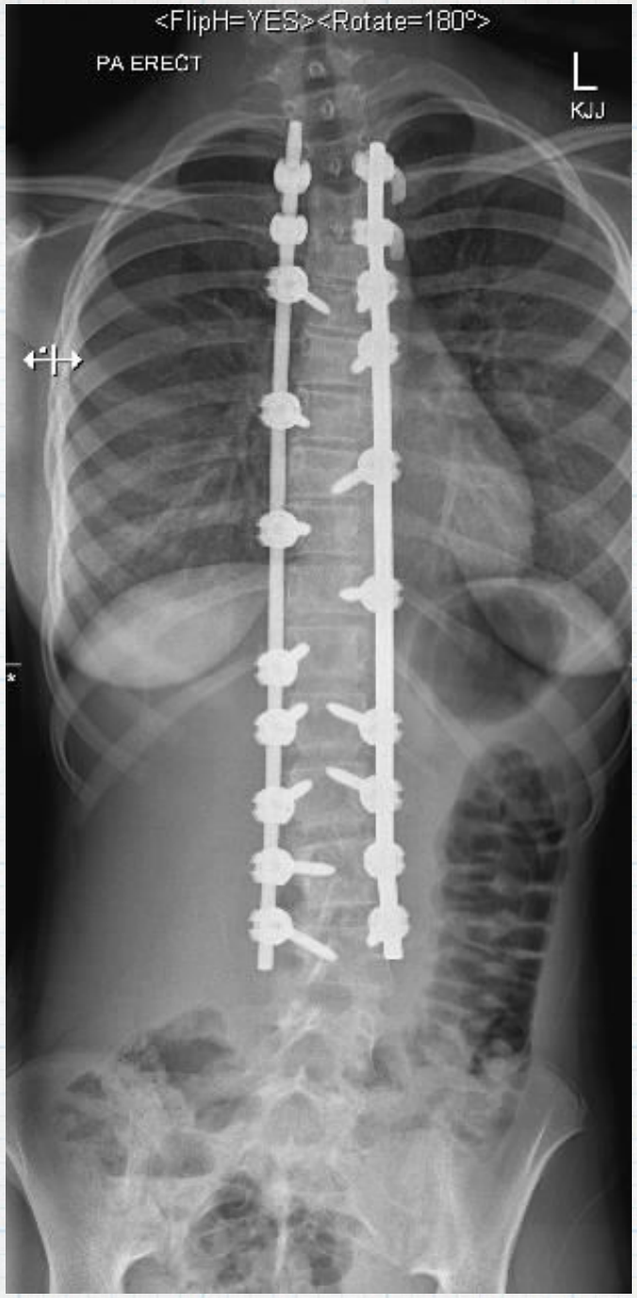
15 / M

Scheuermanns disease

Posterior correction T3 to L2

Thoracic kyphosis 77º to 40º

6’1” to 6’4”

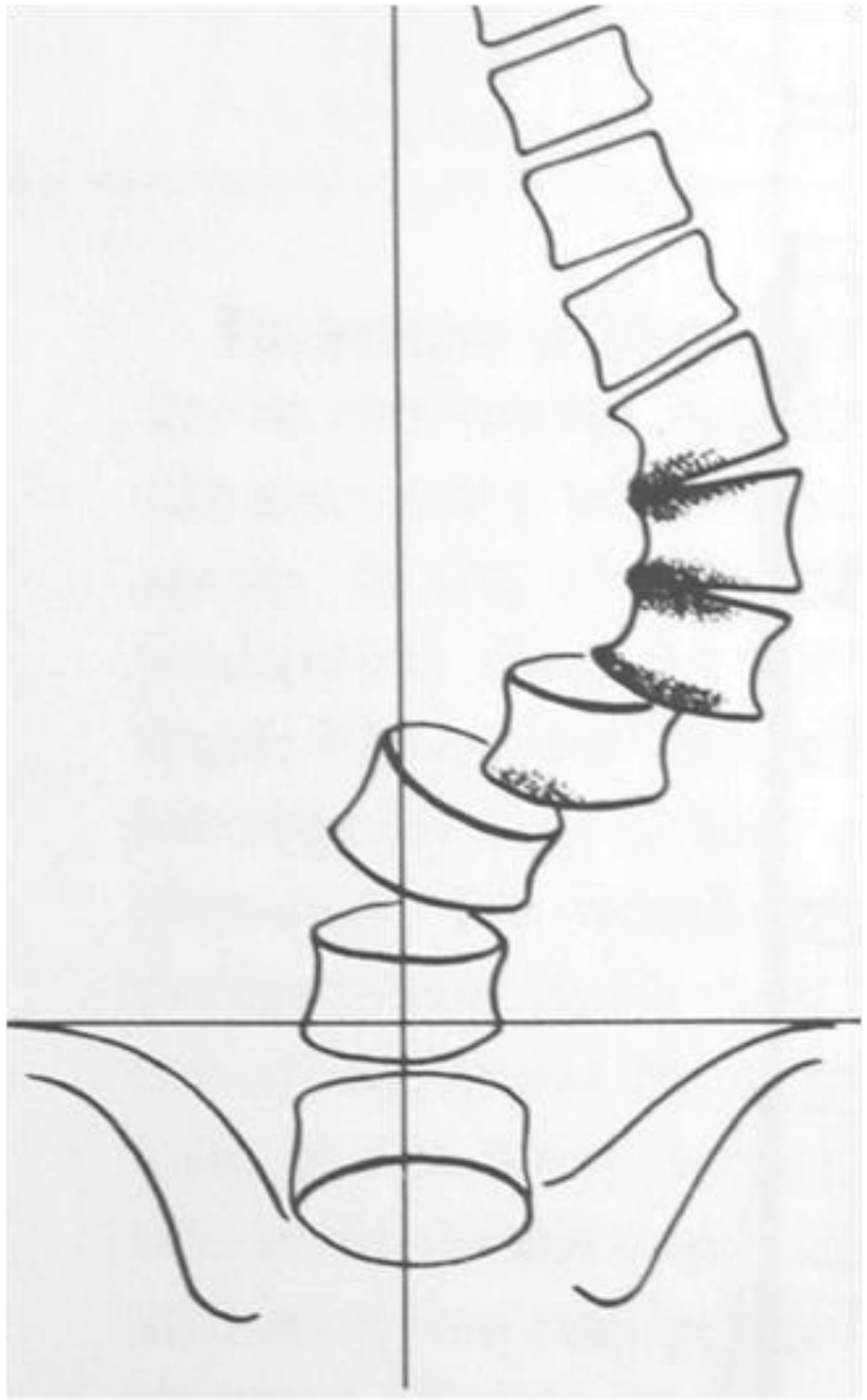


13 / F post menarchal
Posterior correction T3 to L3
Thoracic 49° to 09°
Lumbar 38° to 10°
Thoracic kyphosis 24° to 40°

AIS: newer technologies

* Intra-op CT
* Low dose X-rays

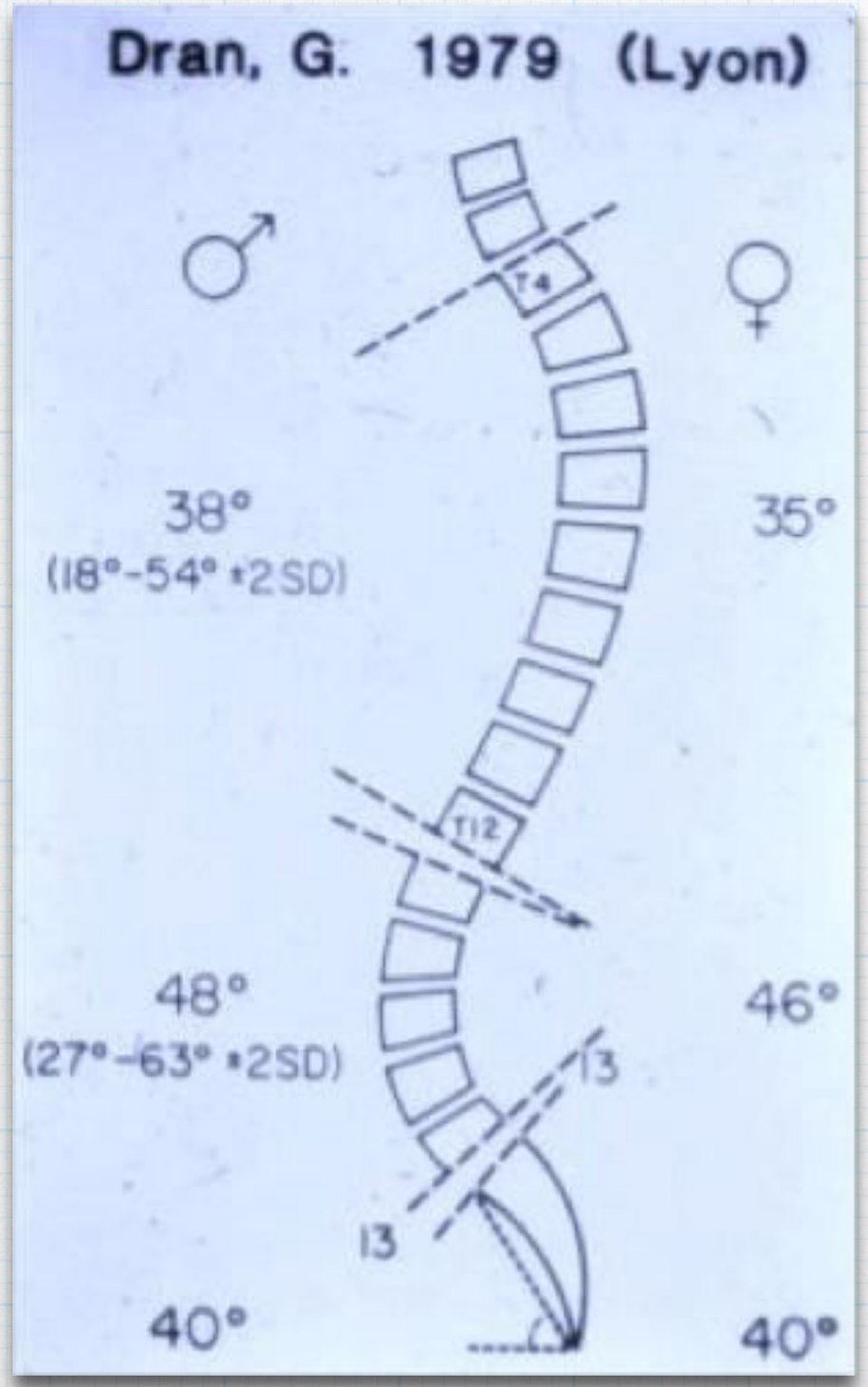
Adult spinal deformity



Sagittal plane

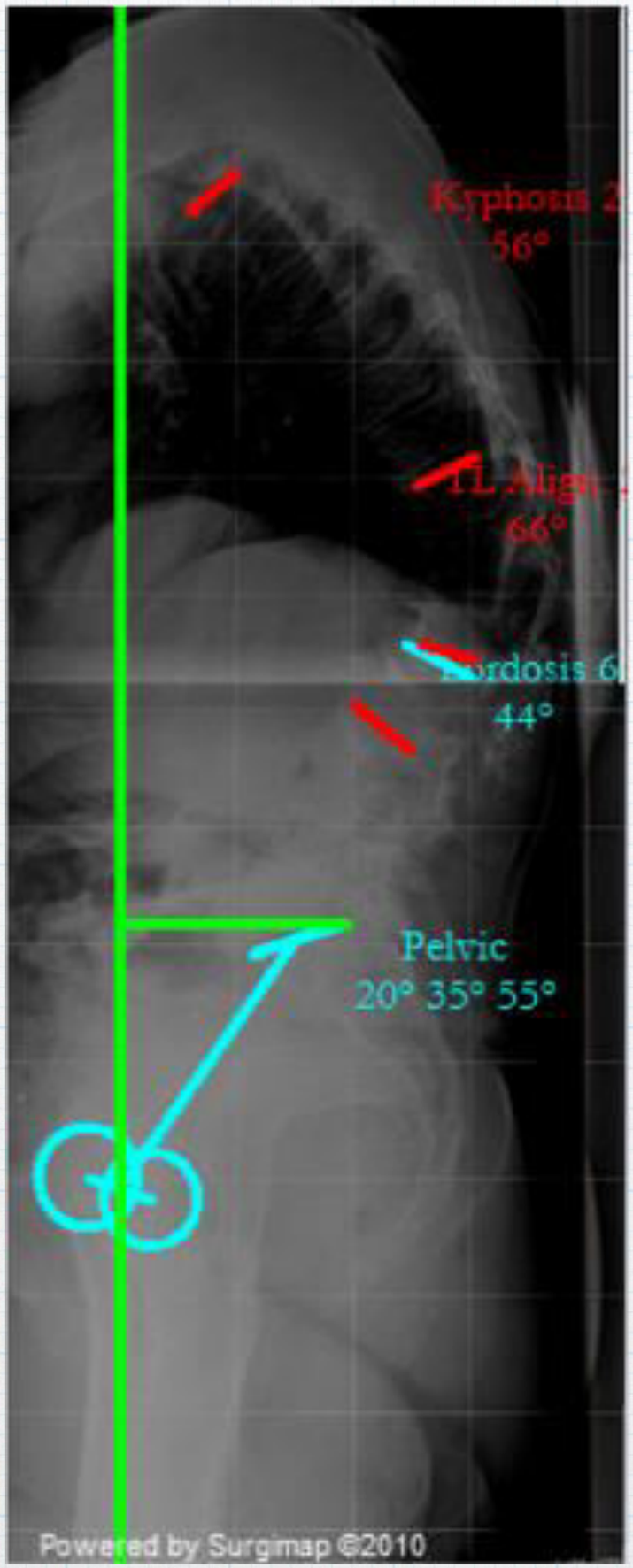
Idiopática

The spinal finger print



Measures:

* Lumbar lordosis
* Thoracic kyphosis
* Sagittal vertical axis
* Pelvic parameters



59 / F

AP Cobb 26°

CSL 7 cm

Pelvic:

PI 55°

SS 20°

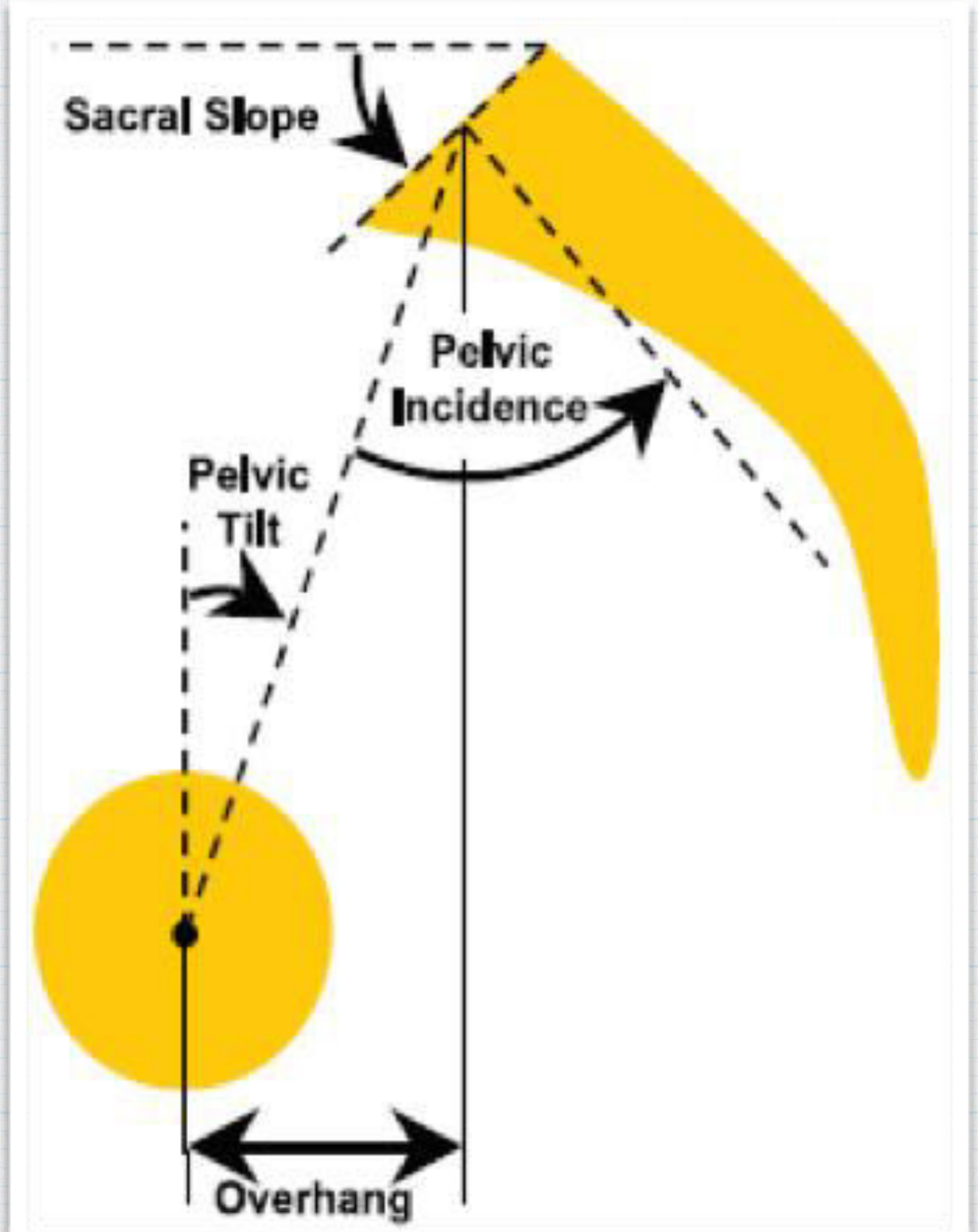
PT 35°

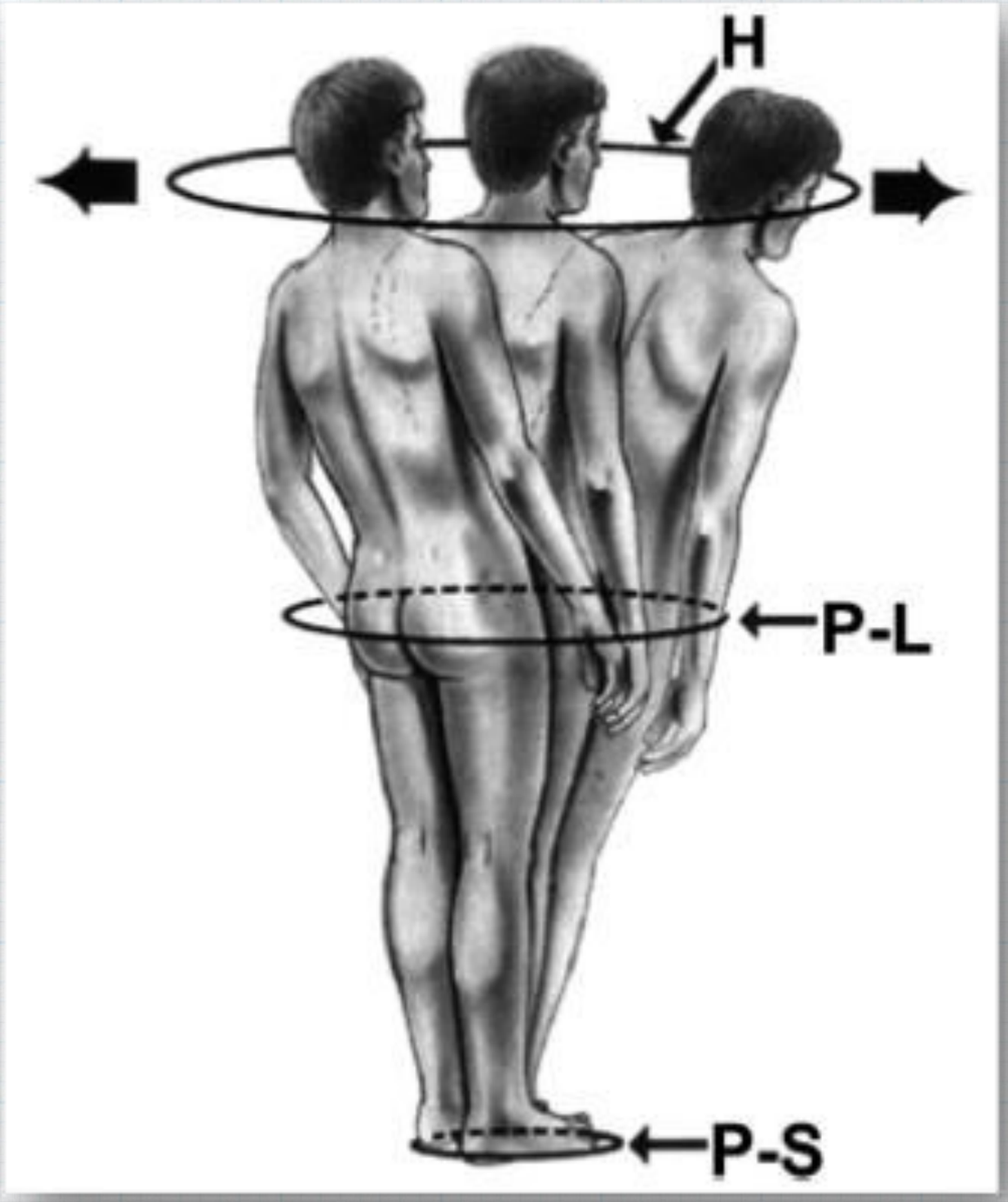
LL 44°

TL 66°

TK 56°

SVA 11 cm


Sacral Slope
Pelvic
Incidence
Pelvic
Tilt
Overhang


H
P-L
P-S

ASD: patient related issues

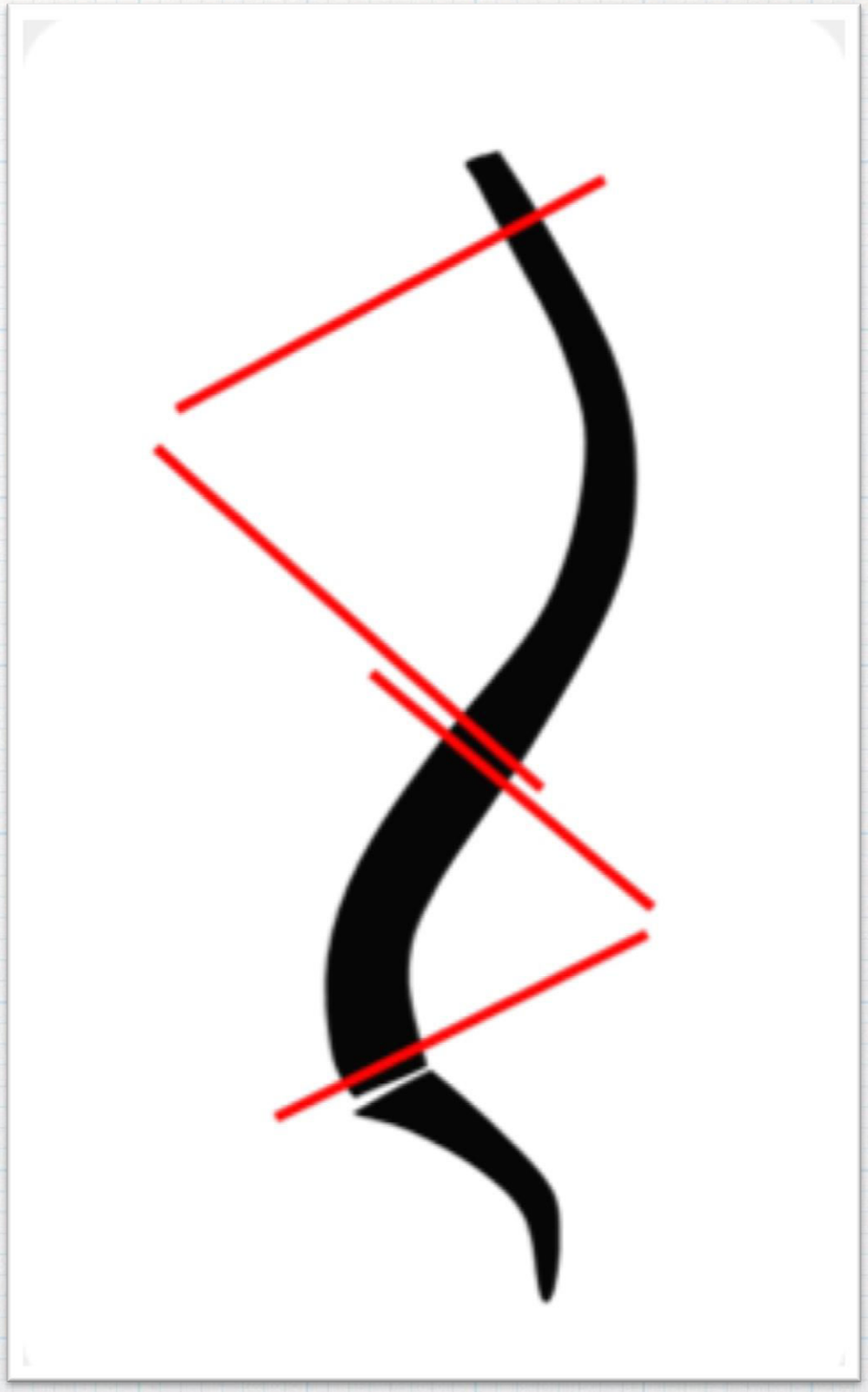
* Medical co-morbidities
* Bone density
* Nutritional status
* Realistic outcomes

ASD: pre-operative assessment

* Anaesthetic assessment
* Bleeding (intra-op): cell salvage, tranexamic acid
* Spinal cord monitoring

Aims of intervention

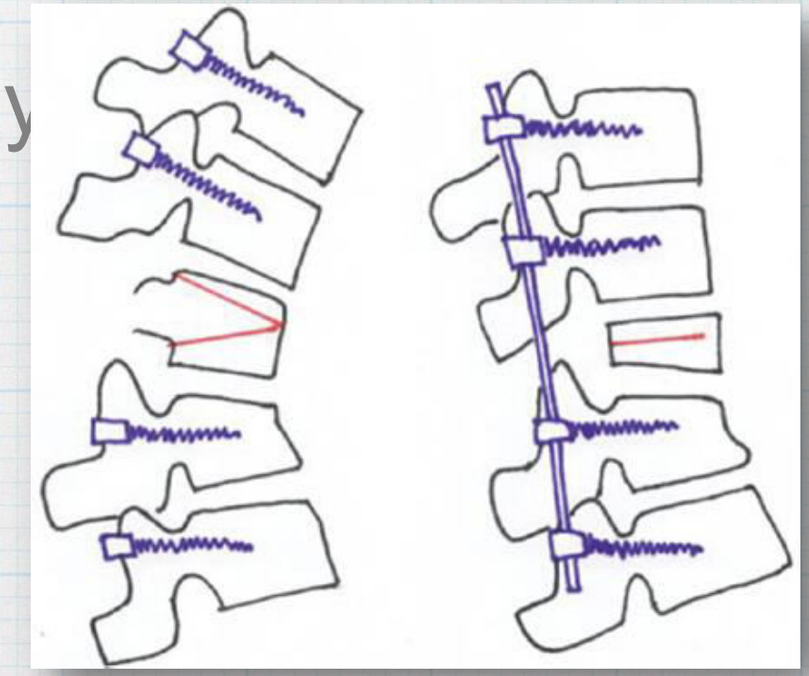
* Adapt lordosis
* Restore plumb line
* Decompress nerves
* Achieve solid fusion
* Head above the pelvis

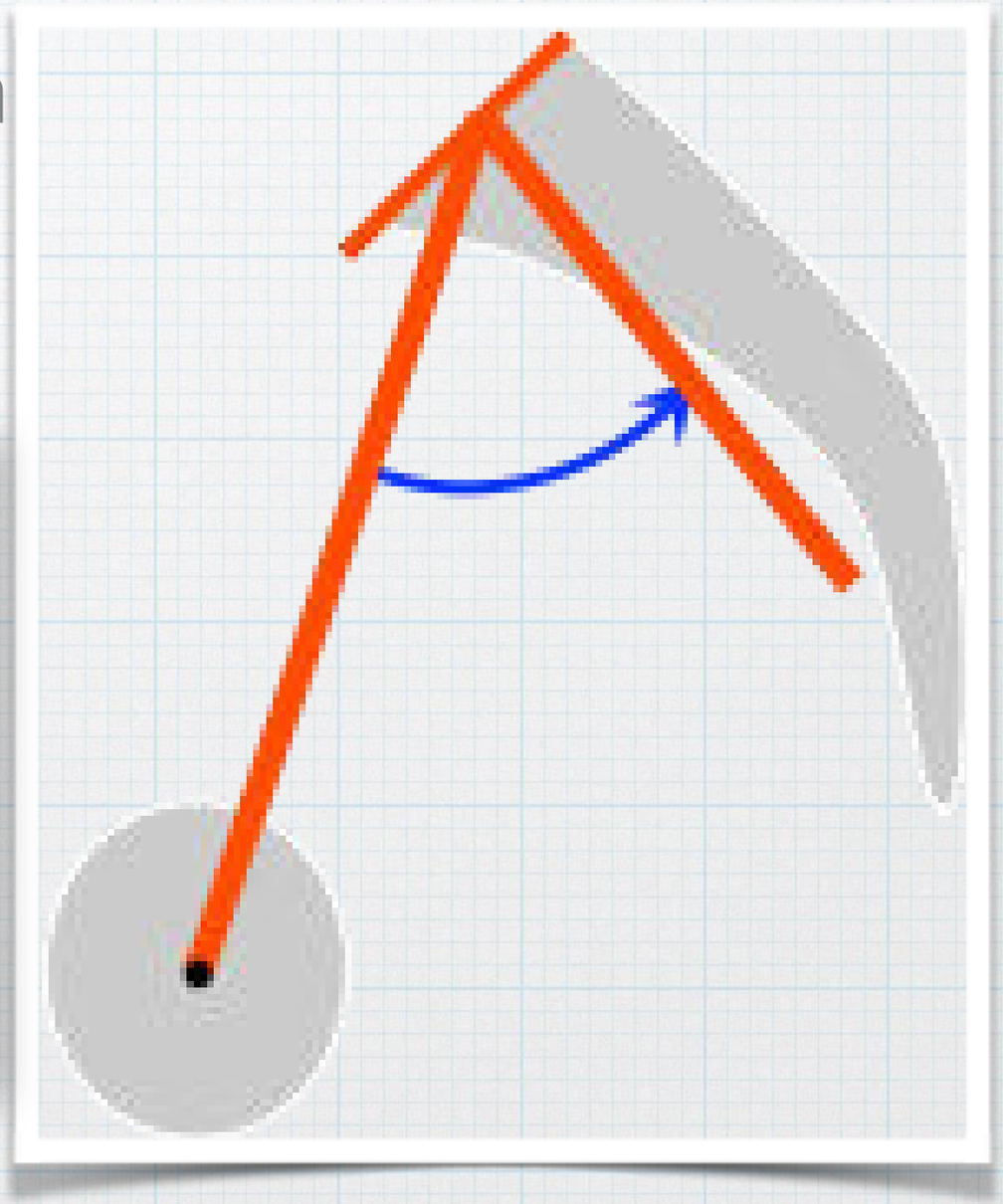


Adapting the lordosis

LL=PI ± 9°

* Identify the ‘ideal’ for that person
* Excise facets, open up the discs
* Facetectomy
* Discectomy
* Osteotomy





PI 60º

LL 44º to 72º

TK 32º to 67º

PI 48º

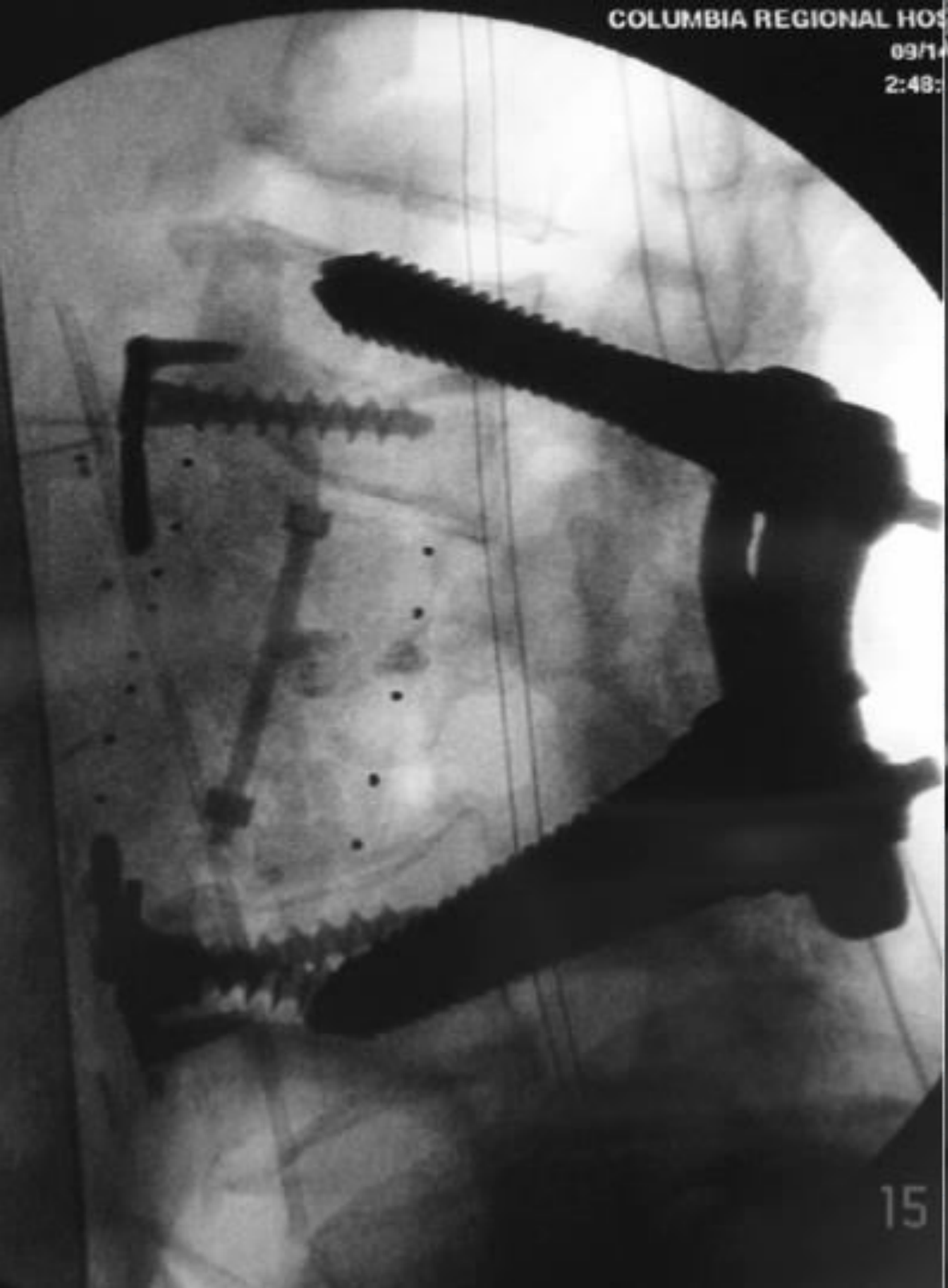
LL 25º to 41º

Anterior:
L12, 23, L34
discectomy

Posterior:
T10 – L5


6 5:50PM


EXIT


COLUMBIA REGIONAL HOS
09/14
2:48:
15


Spin -90
Tilt -2


WdhS:l 18

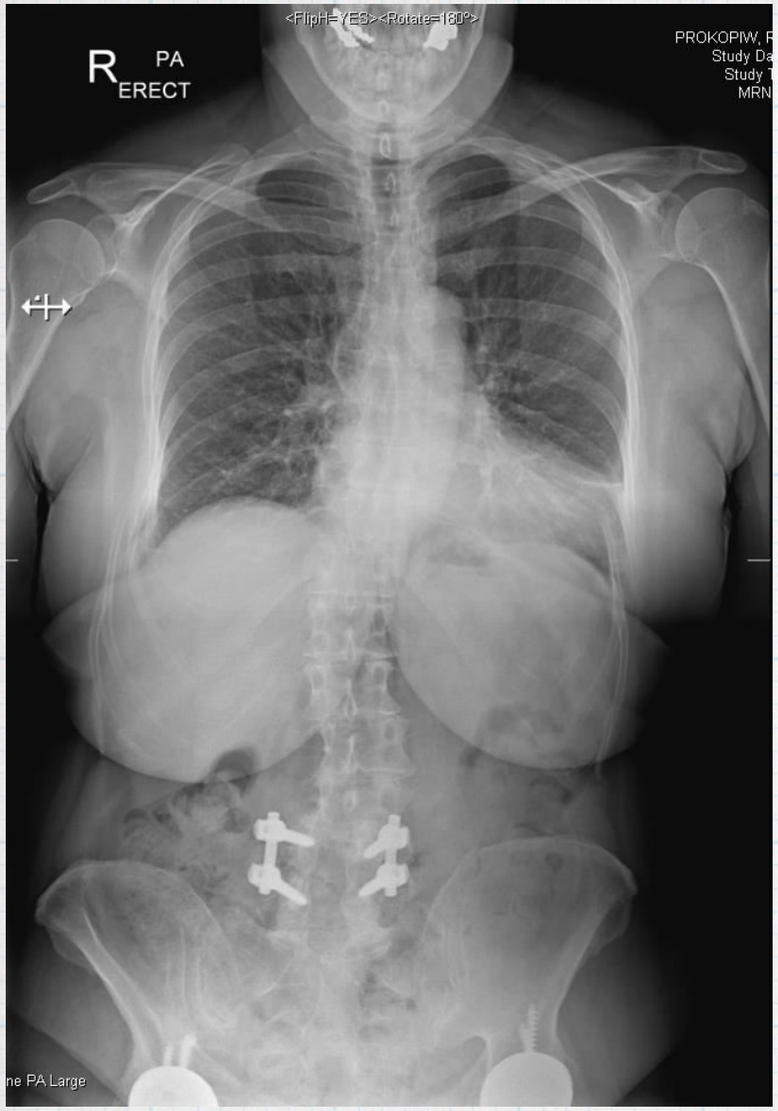
ASD: logistical issues

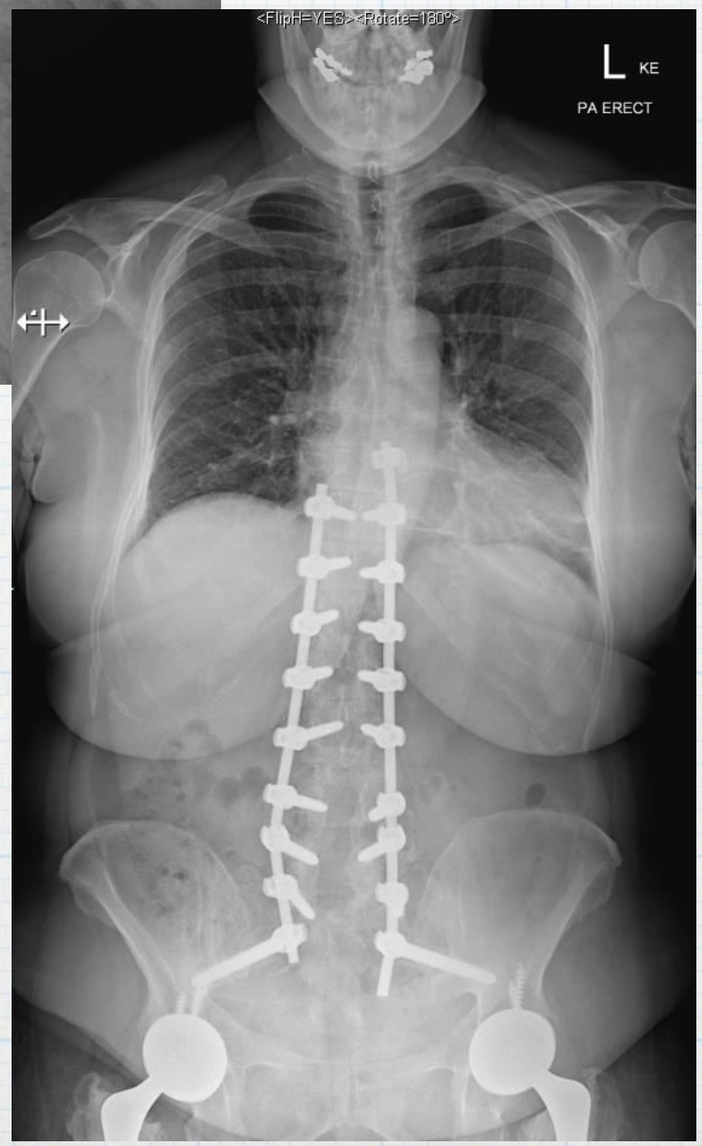
* Institutional back up
* MDT set up
* Robust conservative options
* Realistic expectations

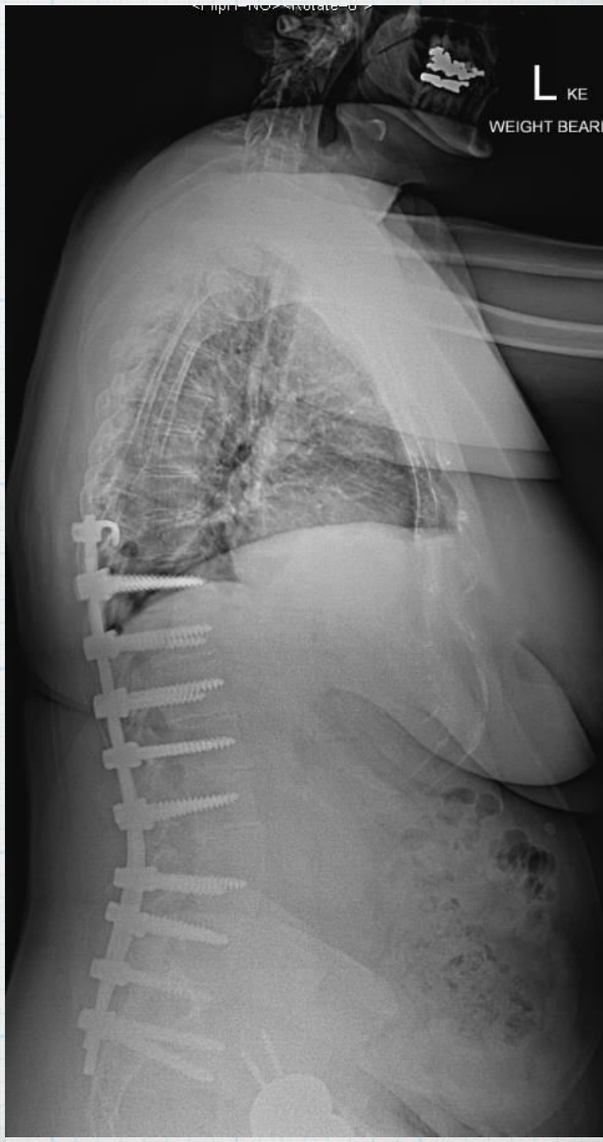
PI 40º

LL 9º to 33º

SVA 18.3 to 1 cm







PI 55°

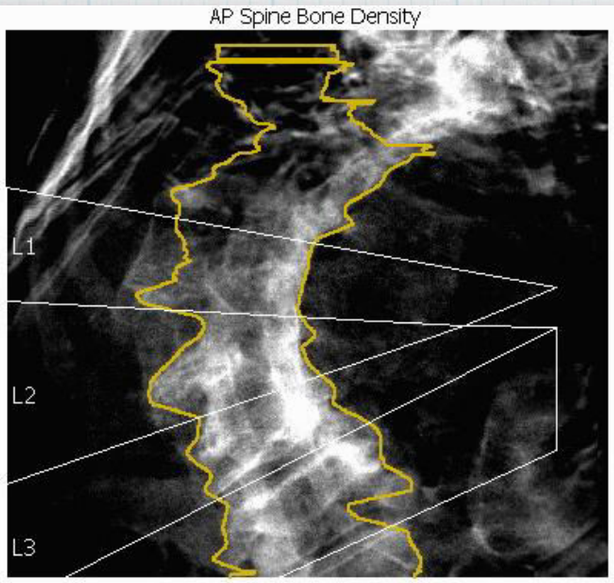
LL 24° to 41°

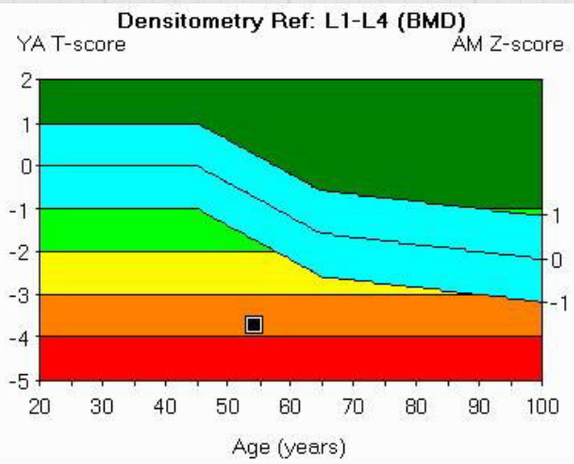
TK 14° to 47°

SVA 11 to 4.8 cm

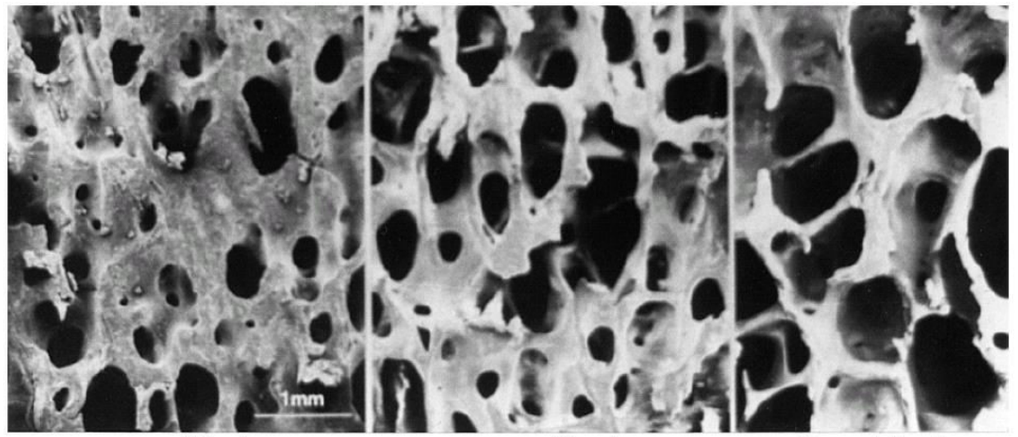
ASD: risk assessments

* Risk assessment: basis of informed choice and appropriate care
* Reducing variability: Variability is a proxy for quality of care
* Clinical practice guidelines





Region	[1] BMD (g/cm²)	[2] Young-Adult T-score	[3] Age-Matched Z-score
L1	0.522	-5.1	-4.3
L2	0.779	-3.5	-2.8
L3	0.886	-2.6	-1.9
L4	0.738	-3.8	-3.1
L1-L4	0.732	-3.7	-3.0



24 year old female control WB | 63 year old female control WB | 89 year old female fracture WB

Figure 38

Age-related changes in apparent density and architecture of human trabecular bone from the lumbar spine. (Courtesy of Marc D. Grynpas, PhD.)

* Pre-op identification with DEXA
* Antiresorbtive Medications (Bisphosphonates)
* Anabolic Medications (Teriperatide)
* Fixation Strategies for the Osteoporotic Spine

Scoliosis Research Society Morbidity and Mortality of Adult Scoliosis Surgery

Charles A. Sansur, MD, MHSc,* Justin S. Smith, MD, PhD,† Jeff D. Coe, MD,‡ Steven D. Glassman, MD,|| Sigurd H. Berven, MD,§ David W. Polly Jr., MD,¶ Joseph H. Perra, MD,# Oheneba Boachie-Adjei, MD,** Christopher I. Shaffrey, MD†

SPINE Volume 36, Number 9, pp E593–E597

* ***4980 cases of adult scoliosis between 2004 and 2007***
* ***521 patients with complications (10.5%)***
* **Predictors** of complications:
    1. Osteotomies
    2. Revision Surgery
    3. Combined Anterior/Posterior Approaches
* **Non-predictors:** Age and type of scoliosis

YOUR SPINE TREATMENT CALCULATOR

This calculator shows possible patient results for physical activity, pain and overall health after surgical or non-surgical treatment for low back related pain. The data used come from the Spine Patient Outcomes Research Trial (SPORT)*. This tool is for people whose doctor has told them that they have one of the diagnoses listed below.

Choose one of the diagnoses below.

Sciatica/Ruptured Disc (Herniated Disc): A vertebral disc is a soft gel-like structure with a normally strong covering that sits between each vertebra in your back and acts like a cushion. A herniated disc happens when this disc has broken down and part of it is pressing on a nerve. The pressure causes pain that most often runs from your back through your buttocks and down one leg.

Pinched Nerve (Spinal Stenosis): This is usually from arthritis in the back. The pain is generally in the lower back and it may also shoot down your leg from your buttocks when walking, but not sitting.

Slipped Vertebra (Degenerative Spondylolisthesis or DS): DS is a condition in which one or more vertebrae move out of place, usually forward, and cause pain similar to that felt with spinal stenosis (see above).

This calculator does not apply to other diagnoses or to a combination of diagnoses.

Select your diagnosis:

- ○ Sciatica/Ruptured Disc (Herniated Disc)
- ○ Pinched Nerve (Spinal Stenosis)
- ○ Slipped Vertebra (Degenerative Spondylolisthesis or DS)

Proceed to Calculator

SpineSage™

SpineSage is a predictive modeling tool based on data from the Spine End Results Registry: 1476 patients

The Spine End Results Registry

Prospectively collected data registry for all patients undergoing spine surgery at Harborview Medical Center and University of Washington Medical Center from January 1st 2003, to December 31st, 2004.

Several multivariate log-binomial analyses were performed to identify and quantify risk factors for these complications after spine surgery and have been published in the peer-refereed literature.

ACS NSQIP® Surgical Risk Calculator

American College of Surgeons
Inspiring Quality: Highest Standards, Better Outcomes

Risk Calculator Home Page | About | FAQ | ACS Website | ACS NSQIP Website

Please enter as much of the following information as you can to receive the best risk estimates.
A rough estimate will still be generated if you cannot provide all of the information below.

Age Group
75-84 years

Sex
Female

Functional Status
Partially Dependent

Emergency Case
No

ASA Class
Severe systemic disease

Steroid use for chronic condition
No

Ascites within 30 days prior to surgery
No

Systemic Sepsis within 48 hours prior to surgery
None

Ventilator Dependent
No

Disseminated Cancer
No

Diabetes
Oral

Hypertension requiring medication
Yes

Congestive Heart Failure in 30 days prior to surgery
No

Dyspnea
No

Current Smoker within 1 Year
No

History of Severe COPD
No

Dialysis
No

Acute Renal Failure
No

BMI Calculation:

Height (in) 66

Weight (lbs) 170

ACS NSQIP®

Surgical Risk Calculator

American College of Surgeons
Inspiring Quality: Highest Standards, Better Outcomes

Procedure: 22207 - Osteotomy of spine, posterior or posterolateral approach, 3 columns, 1 vertebral segment (eg, pedicle/vertebral body subtraction); lumbar

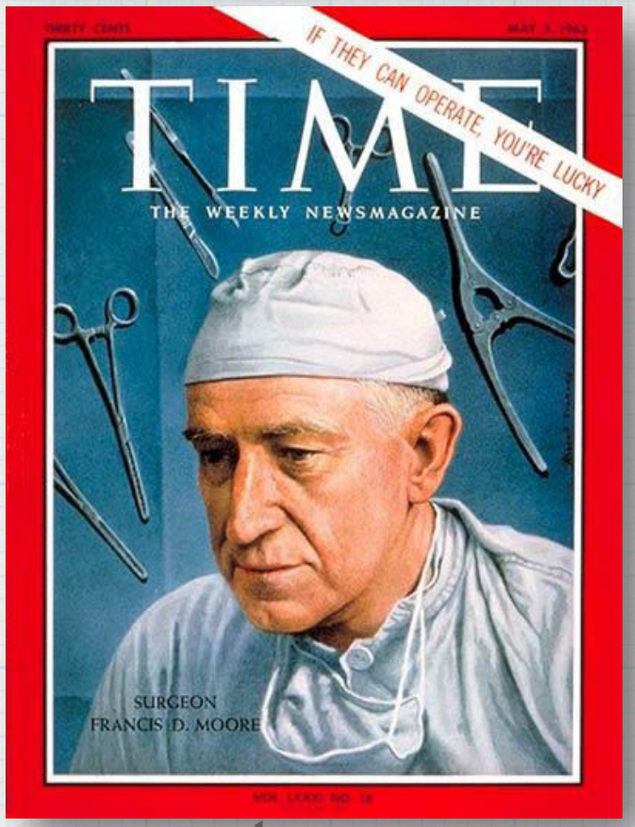
Risk Factors: 75-84 years, Partially dependent functional status, ASA Severe systemic disease, Diabetes (Oral), HTN, Over Weight

Change Patient Risk Factors

Outcomes	Your Risk	Average Risk	Chance of Outcome
Serious Complication	28.0%	18.3%	Above Average
Any Complication	29.5%	19.9%	Above Average
Pneumonia	3.9%	2.0%	Above Average
Cardiac Complication	1.3%	0.4%	Above Average
Surgical Site Infection	2.9%	2.7%	Average
Urinary Tract Infection	8.0%	2.6%	Above Average
Venous Thromboembolism	4.6%	3.2%	Above Average
Renal Failure	0.3%	0.2%	Above Average
Readmission	11.8%	7.7%	Above Average
Return to OR	6.8%	5.6%	Above Average
Death	1.2%	0.3%	Above Average
Discharge to Nursing or Rehab Facility	84.1%	30.1%	Above Average

ASD: surgery related issues

- How much should we correct?
- Complications
- Unplanned returns to theatre



Accountability for the results of care is the most fundamental requirement of a healthcare provider.

It may be impossible to avoid complications in spine surgery. We are accountable for how we manage our complications

Major Complications:

Adverse events that require return to the operating room or prolonged inpatient or outpatient care, or irreversible pathology directly related to surgery (life changing)

Ex: Infection, neural injury, pulmonary emboli, junctional pathology, symptomatic non-union, prolonged ICU stay, readmissions

Minor Complications:

Adverse events that do not require prolonged inpatient or outpatient care.

Ex: Dural tear, UTI, transient radiculopathy

An economic evaluation of perioperative adverse events associated with spinal surgery

Erik K. Hellsten, BA[a,b], Michelle A. Hanbidge, BESc[c], Aspasia N. Manos, BSc[a], Stephen J. Lewis, MD, FRCSC[d,e], Eric M. Massicotte, MD, FRCSC[e,f], Michael G. Fehlings, MD, PhD, FRCSC[e,f], Peter C. Coyte, PhD[a], Y. Raja Rampersaud, MD, FRCSC[d,e,*]

The Spine Journal 13 (2013) 44–53

Grading adverse events by clinical impact:

I: No or Minimal Treatment Required

II: Treatment required with no expected sequelae at > 6mos

III: Treatment required with expected sequelae at >6 mos

IV: Death

ASD: societal issues

* Economic impact
* Longer and more active lives

When do you refer

- Unable to stand upright
- New ‘forward gaze’ issues
- Static or dynamic ‘stoop’
- Loss of ‘height’