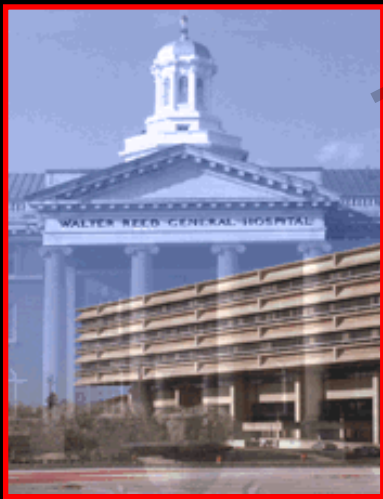


# Posterior Only Surgery for Adolescent Idiopathic Scoliosis



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Scoliosis Research Society 2011 Traveling Fellowship

# “Reasons for Anterior Release/Fusion and PSF

- ↑ Spinal flexibility
- ↑ Fusion rate
- Prevent Crankshaft in skeletally immature patients

1. Dobbs and Lenke et al. Anterior/posterior spinal instrumentation versus posterior instrumentation alone for the treatment of adolescent idiopathic scoliotic curves more than 90 degrees. Spine 2006.

2. Luhmann and Lenke et al. Thoracic adolescent idiopathic scoliosis curves between 70 degrees and 100 degrees: is anterior release necessary? Spine 2005

# “TRADITIONAL INDICATIONS” FOR ANTERIOR RELEASE

- Large curve magnitude ( $>70-90^\circ$  coronal plane)
- Excessive kyphosis ( $>80-90^\circ$  sagittal plane)
- Inflexibility (residual S.B. or H.E. Cobb  $>50^\circ$ )

# Techniques to Avoid ASF/PSF

- Pedicle Screws (esp. TPS)
- Posterior Facet/Ligament Releases (Ponte, Smith-Petersen – SPOs)
- Halo-Traction (Preop, Intraop)
- Correction methods utilizing Segmental Screw Fixation and Creep & Stress Relaxation of perispinal tissues
- PSOs & VCRs → for more severe deformities

# TREATMENT OPTIONS

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## PAST

- Thoracic Hooks
- Anterior Releases/ASF
- Thoracoplasty
- Lumbosacral ASF
- ICBG

## CURRENT

- Thoracic Pedicle Screws (TPS)
- Post Releases (POs/SPOs)
- Aggressive Deformity Correction
- DVR or TDVR

# PROGRESSION OF *POSTERIOR TECHNIQUES*

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- Posterior SCREWS alone
- Add Post. Ligament Releases
- Add SPOs/POs
- Add PSO or VCR

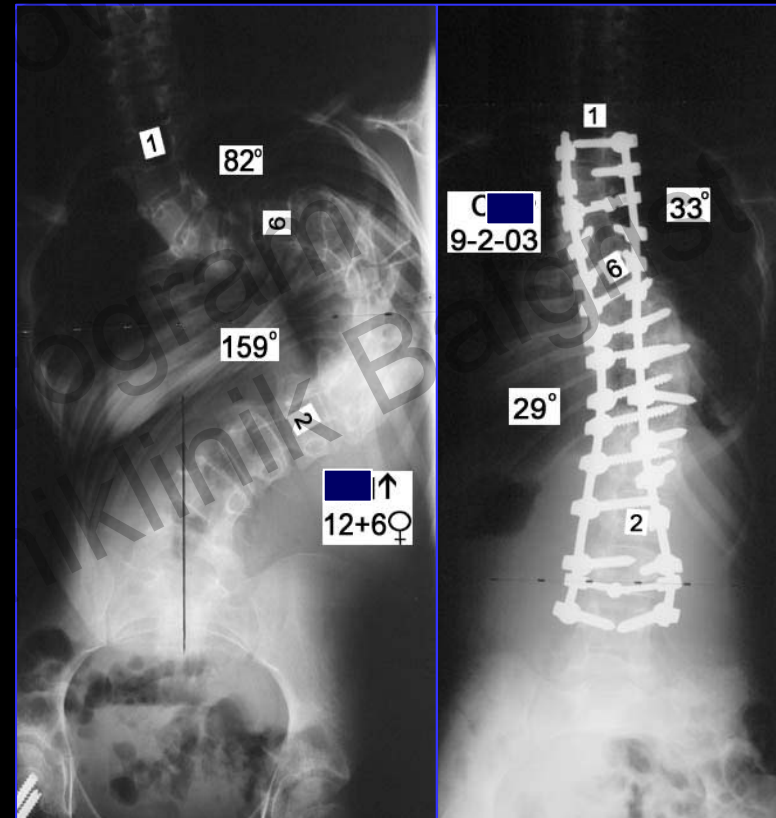
# TPS – *INSERTION/OPTIONS*

## Various Insertion Techniques

1. **FREE HAND**
2. Pre-insertion K-wire guided
3. Fluoro assist
4. Stealth image guided/Fluoro navigation

## Confirmation of Optimal Placement

1. Triggered EMGs
2. Pedicle seeker/Palpation
3. Post-insertion radiographs or fluoro
4. Laminotomy
5. Postop CT scan



# 4 TYPES OF THORACIC PEDICLES

Thoracic Pedicle Types	#	%
A. Large Cancellous Channel	99	42%
B. Small Cancellous Channel	105	44%
C. Cortical Channel (but intraosseous placement possible!)	24	20%
D. Absent Channel – Pedicle Slit, use “Juxtapedicular” placement	9	4%
	<b>*n= 237</b>	<b>100%</b>

Free-hand pedicle screw placement during revision spinal surgery: analysis of 552 screws.



# TYPE “A” PEDICLE



**LARGE CANCELLOUS ISTHMUS (42%)**

# TYPE “B” PEDICLE

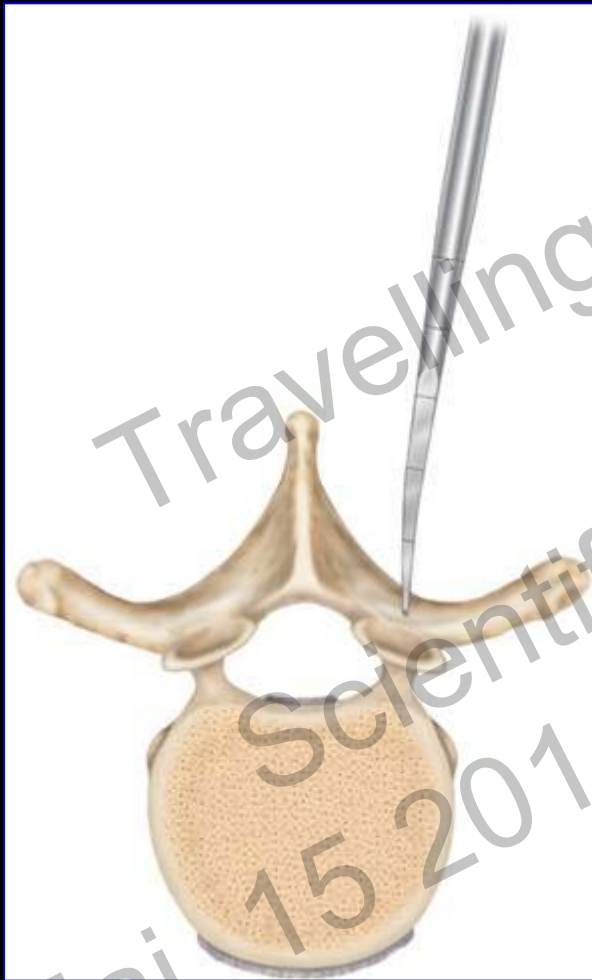
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**SMALL CANCELLOUS ISTHMUS (44%)**

# TYPE "C" PEDICLE

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**CORTICAL ISTHMUS (20%)**

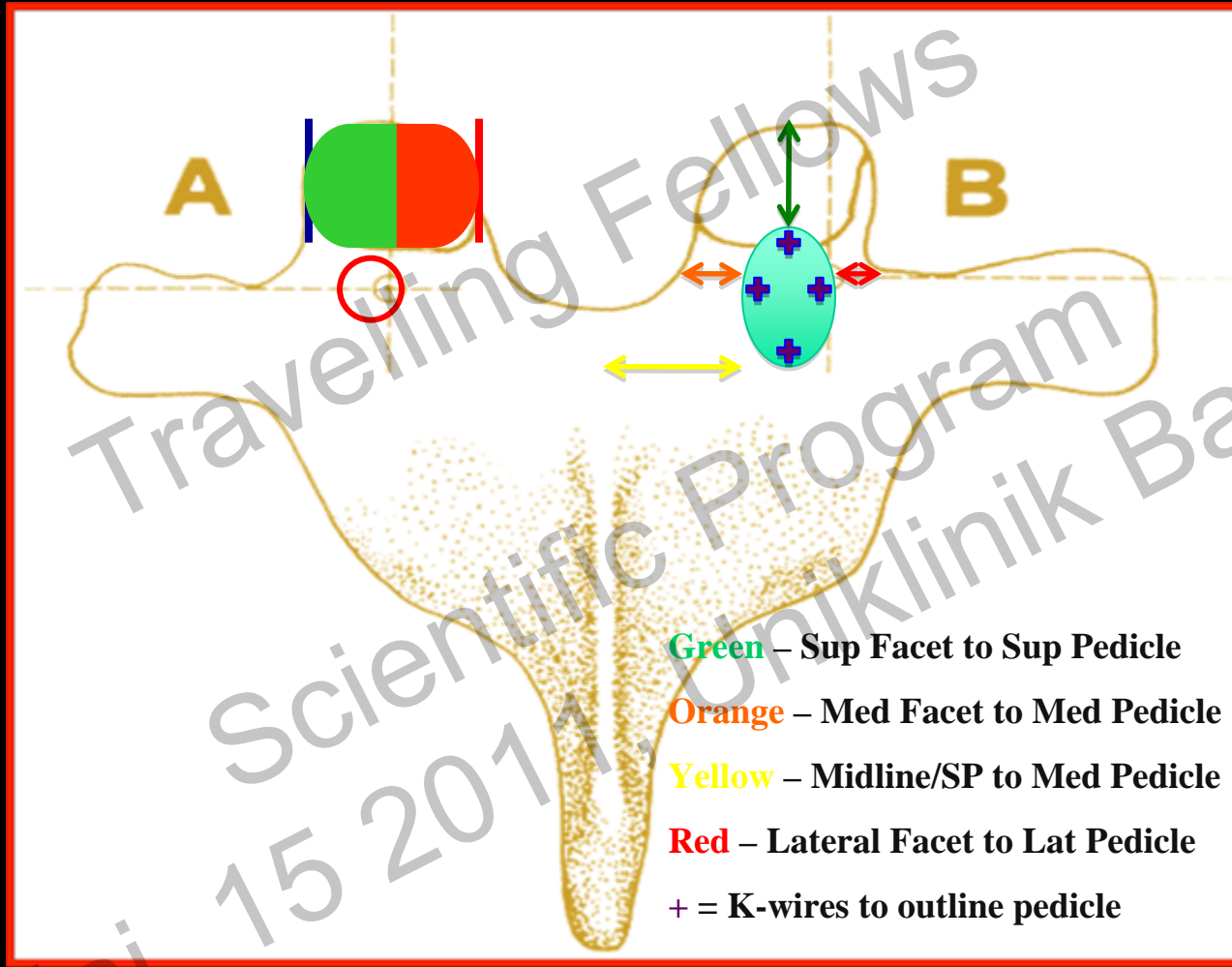
# TYPE “D” PEDICLE

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**ABSENT ISTHMUS/PEDICLE “SLIT” (4%)**

# Superior Facet Rule



**Lehman and Lenke et al. SRS 2011**

# Ventral Lamina



# **Operative Treatment of Adolescent Idiopathic Scoliosis with Posterior Pedicle Screw Constructs: Minimum 3-year follow-up of 114 Cases**

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Ronald A. Lehman, Jr., MD and Lawrence G. Lenke et al Spine 2008.

Walter Reed Army Medical Center, Washington, D.C.  
Washington University School of Medicine, St. Louis, MO

# INTRODUCTION

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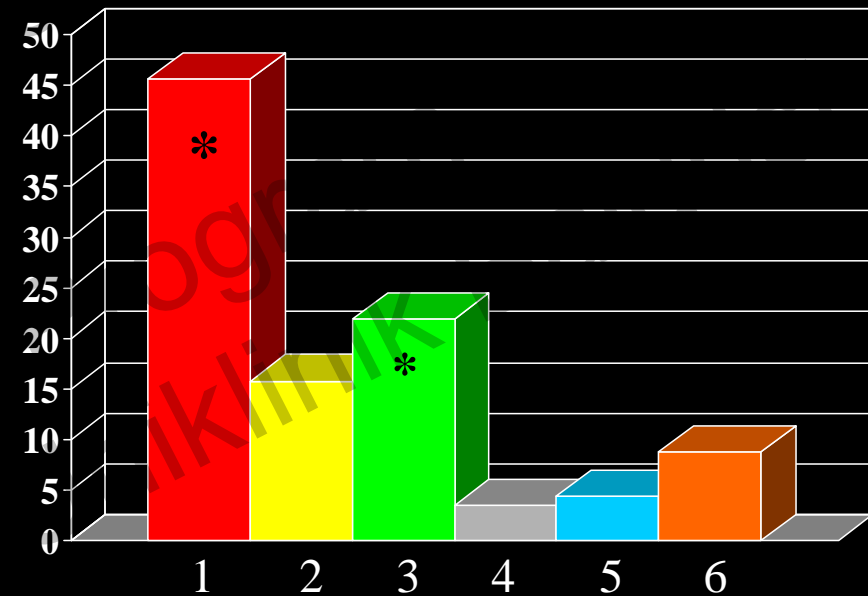
- Pedicle screw-only constructs for deformity surgery
  - Safe and effective
    - Belmont et al. *Spine* 2001
  - Significantly better major curve correction, postop PFTs
    - Kim et al. *JBJS (In Press)*
  - Allows for derotation
    - Lee and Suk et al. *Spine* 2004
  - Similar PJK, LIV, operative time, and PO SRS-24
    - Kim YJ et al. *Spine* 2006
  - Superior Biomechanical properties
    - Liljenqvist et al. *Acta Orthop Belg* 2001
  - Allows surgeon to avoid anterior procedures (even  $>70^\circ$ )
    - Luhmann et al. *Spine* 2005
  - TPS for selective thoracic fusion allows maintenance at 5yr
    - Suk et al. *Spine* 2005



# DEMOGRAPHIC DATA

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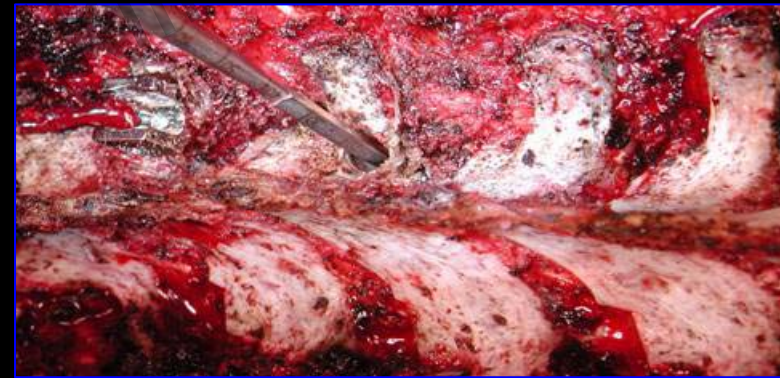
- 114 consecutive AIS pts. w/3-year FU
  - 88 females and 26 males
- Avg. age - 14.9 (12.1-21.86)
- Risser - 3.34 (0-5)
- 34% had thoracoplasty (39/114)
  - Only 2 performed after 2001
- Frequency of Lenke Curve Type
  - Lenke 1 - 45.6%\*
  - Lenke 3 - 21.9%\*
- Avg. # screws/patient - 18.2 (10-28)
- SRS scores at FFU - 83%



# METHODS

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- Straight-ahead trajectory and Free-hand\* technique
- Radiographic measurements
  - AP, LAT, supine, and side-bending
  - Preoperative, postoperative, 2-year, and FFU
- Chart review
  - PFTs
  - SRS scores
  - Lenke classification
  - Complications



\*Kim and Lenke et al. Spine 2004

# CURVE CORRECTION

Curve	Preop	Postop	Final Follow-up
Proximal Thoracic (PT)	26.9° ±10.96 SD	13.5°* ±7.06 SD	13.3° ±8.28 SD
Main Thoracic (MT)	59.5° ±11.96 SD	16.6°* ±9.91 SD	19.3°* ±11.91 SD
Thoracolumbar/ Lumbar (TL/L)	43.2° ±15.76 SD	14.0°* ±10.51 SD	14.9° ±10.27 SD

\*p < 0.001

# SAGITTAL ALIGNMENT

Curve	Preop	Postop	Final Follow-up
T2-5	7.68° ±5.0 SD	9.31°* ±5.0 SD	13.16°* ±8.2 SD
T5-12	25.8° ±12.5 SD	14.4°* ±7.3 SD	15.5°* ±8.6 SD
T12-Sacrum	-59.3° ±13.4 SD	-53.2°* ±12.8 SD	-55.8°* ±12.6 SD

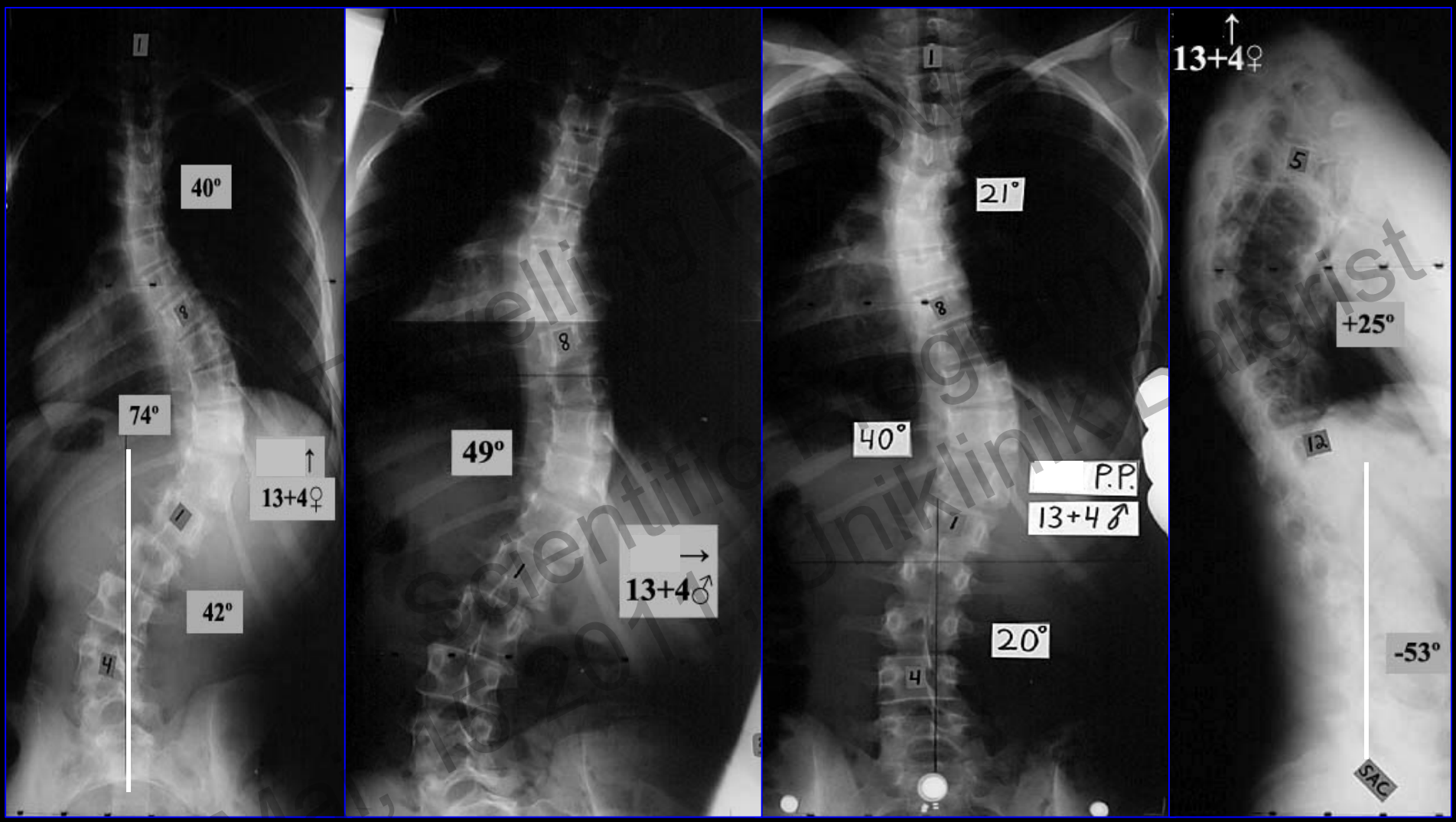
\*p<0.001

# PFTs

Parameter	Preop	Final Follow-up
FVC	2.8 $\pm$ 0.7 SD	3.1 $\pm$ 0.06*
%FVC	77 $\pm$ 14 SD	82 $\pm$ 13.8
FEV <sub>1</sub>	2.3 $\pm$ 0.5 SD	2.6 $\pm$ 0.5*
%FEV <sub>1</sub>	73 $\pm$ 14 SD	79 $\pm$ 13*

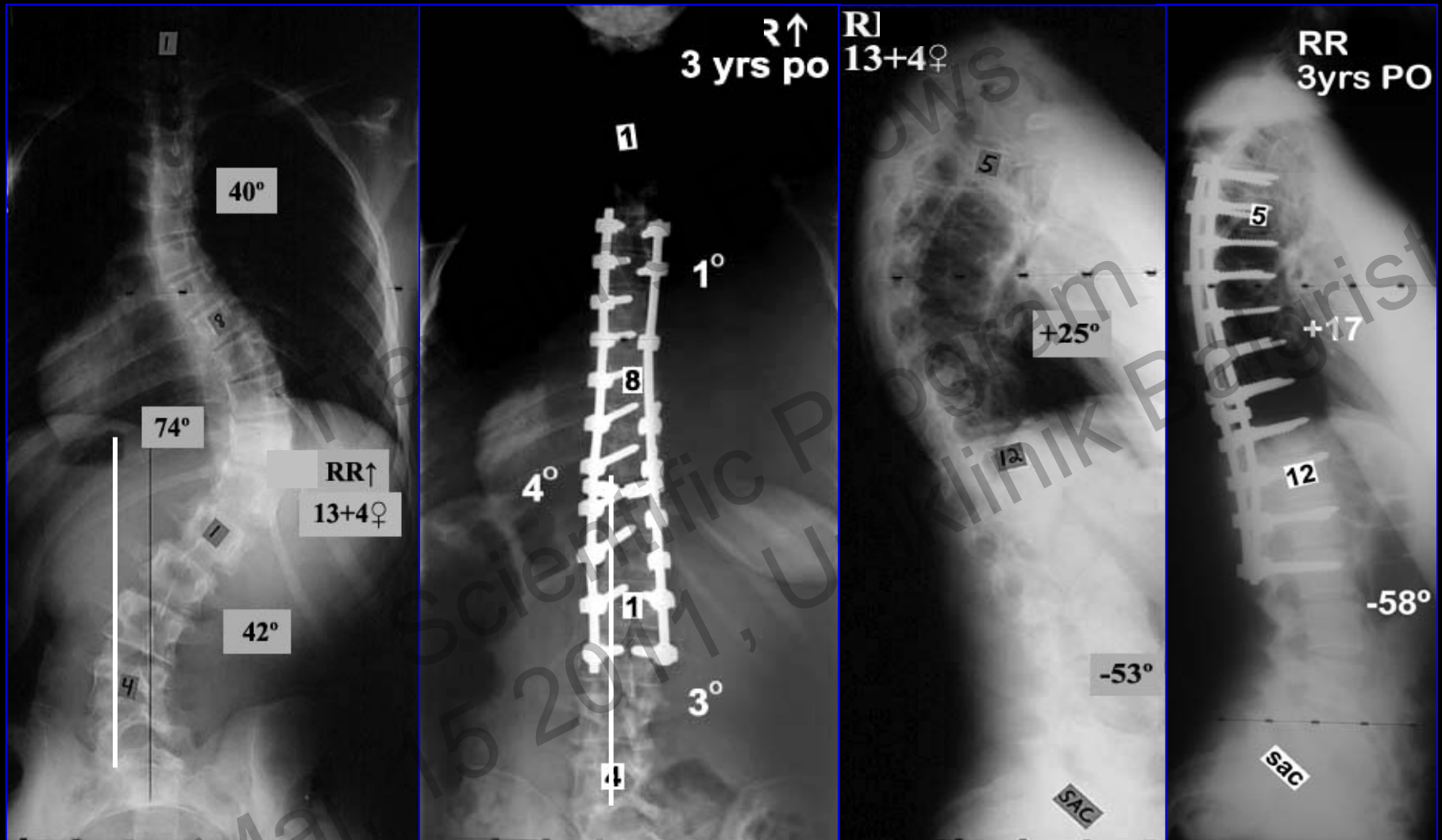
\*p<0.001

# CURVE CLASSIFICATION 1AN



**34% Side Bend Flexibility**

# PSF T4-L2



**95% Correction of Main Thoracic Curve**

# PREOP POSTOP

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# COMPLICATIONS

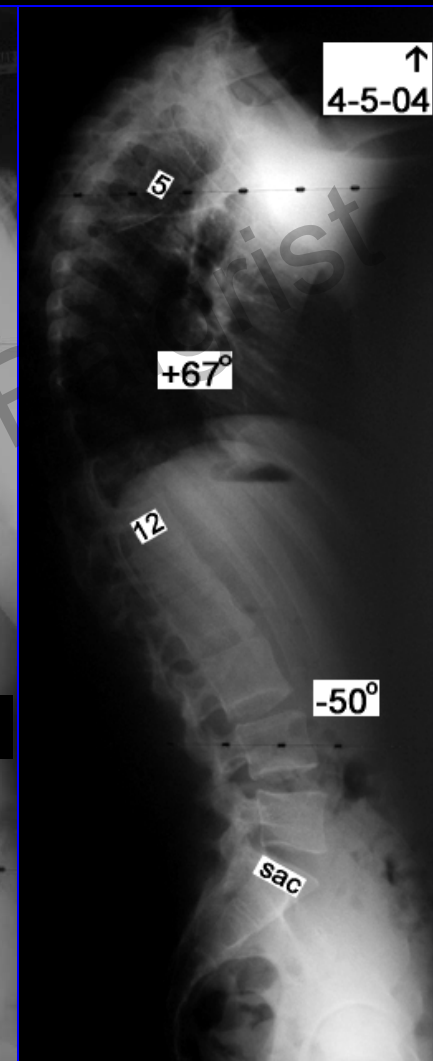
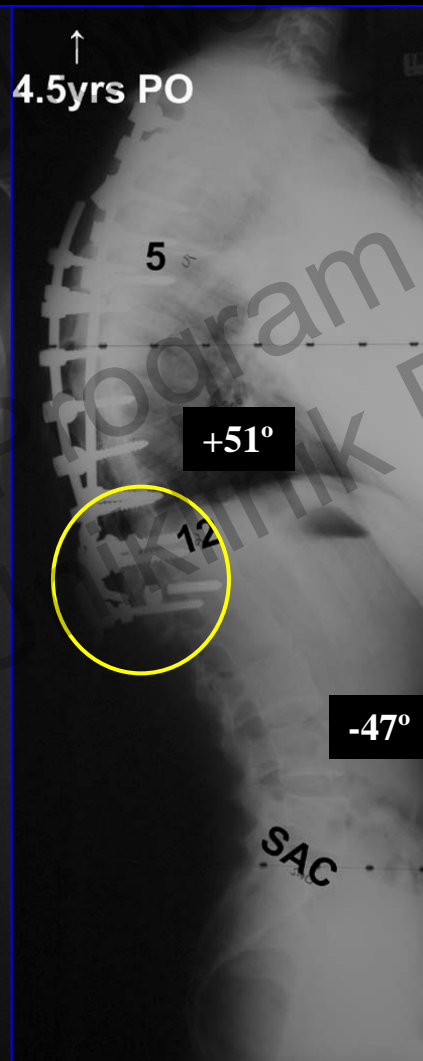
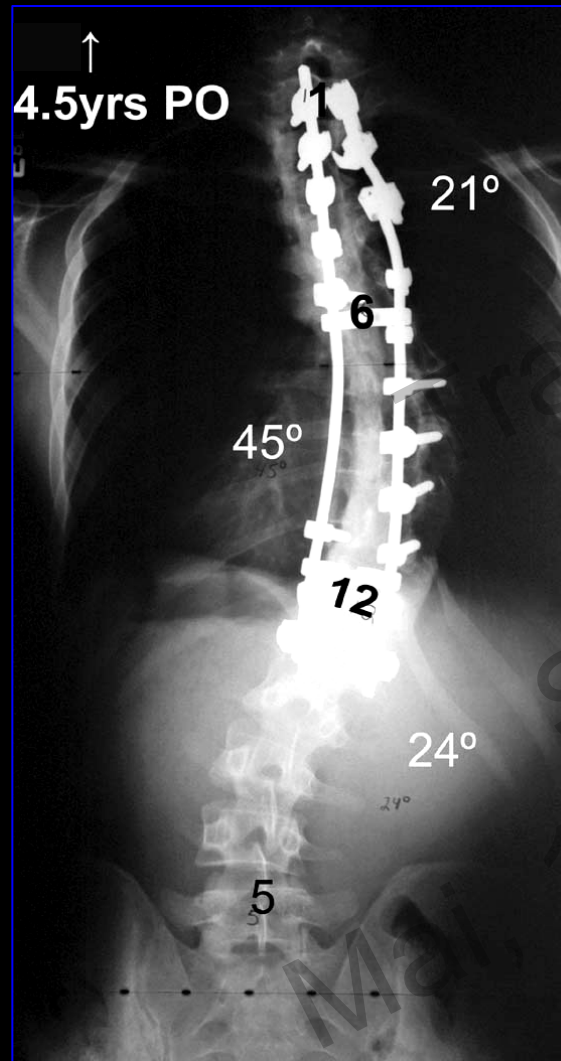
- Two chronic deep wound infections (14-37 months postop)
- Two cases of “adding-on”
  - Mild connective tissue disorders (CTD)
- No neurologic
- No vascular/visceral
- One pseudarthrosis - TOB/Drug abuse postop

# CURVE CLASSIFICATION 2B+

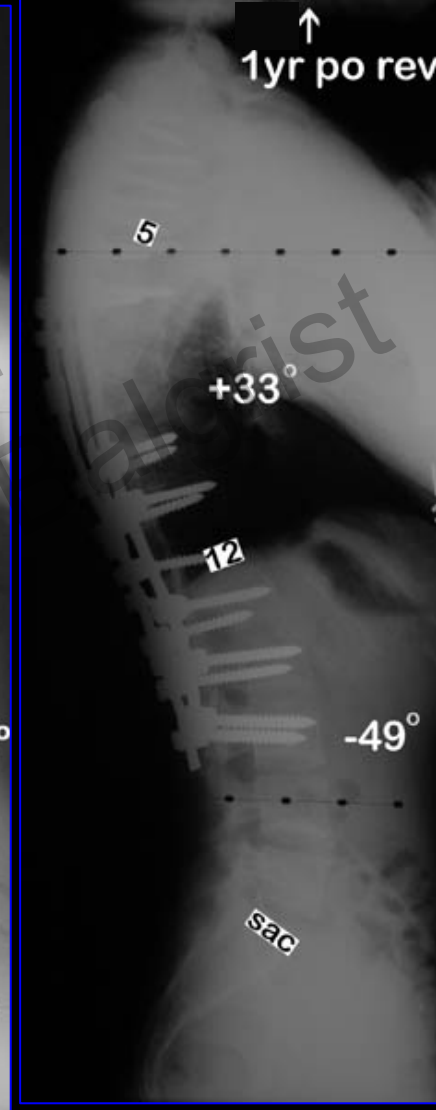
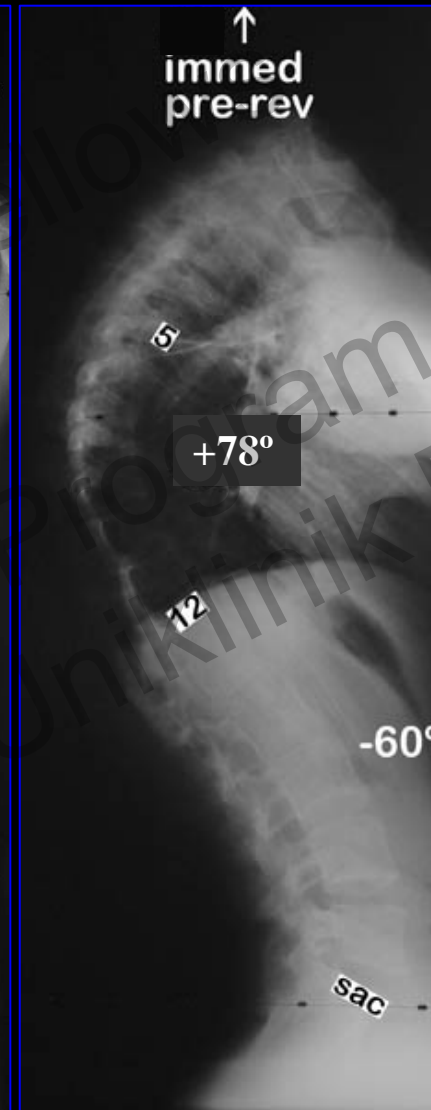
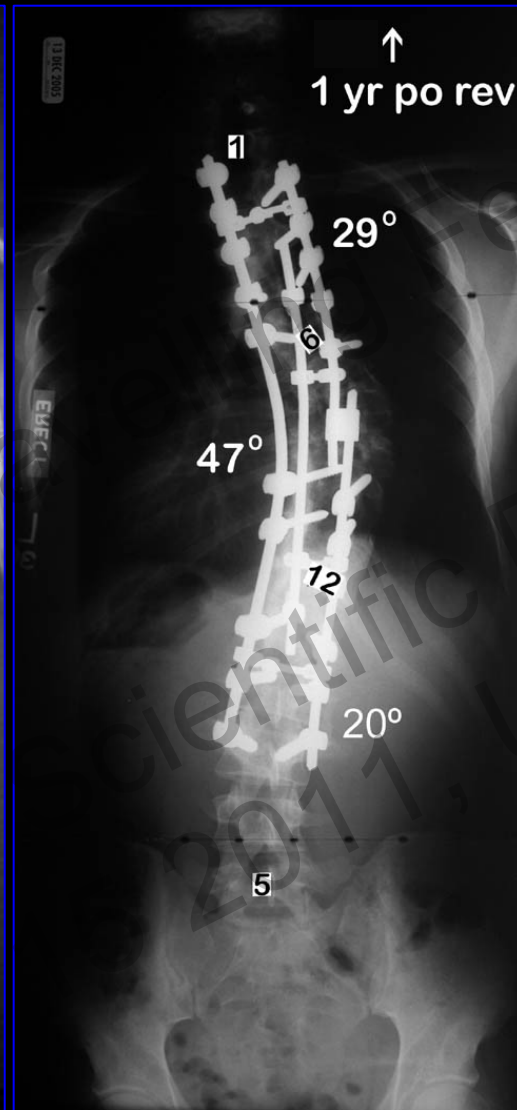


**\*TOB & DRUG USAGE**

# 4.5 YRS POSTOP DRAINING WOUND



# REVISION PSF c̄ SPOs



# CONCLUSIONS

- This is the largest (N=114), consecutive series of North American AIS patients treated with pedicle screws having a minimum 3-year follow-up
- The average curve correction was 50% (PT), 68% (MT), and 66% (TL/L) at final follow-up (FFU)
- Pulmonary function tests (PFTs) improved significantly postoperatively
- There were two cases of adding-on, two chronic infections, one pseudarthrosis, but no neurologic or vascular/visceral complications

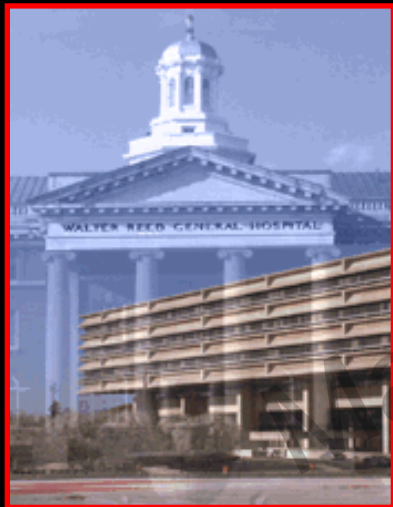
# Change in Time of Radiographic and Balance Parameters for the Operative Treatment of Adolescent Idiopathic Scoliosis: Posterior Pedicle Screw-Only Versus Hybrid Constructs

Ronald A. Lehman, Jr., MD\*

Lawrence G. Lenke, MD

B. Stephens Richards, MD

Keith H. Bridwell, MD



\*Walter Reed Army Medical Center, Washington, D.C.

Texas Scottish Rite Hospital, Dallas, TX

#Washington University School of Medicine, St. Louis, MO



# Introduction

- Screw constructs sig more expensive than hooks
- Correction of PTS ~ Hooks in AIS
  - Storer SK, et al. JPO 2005
- Thoracic Pedicle Screws
  - More expensive
  - Sig. better major and minor curve correction
  - No neurologic problems and improved PFTs
  - Enables shorter fusion length than hooks
  - Kim YJ and Lenke LG, et al. Spine 2004.
- PS or Hybrids offer a sig. better 1° & 2° curve correction in AIS enables sig. shorter fusion
  - Liljenqvist U et al, Eur Spine J, 2002.

# Methods and Materials

- 250 consecutive AIS patients (115-Pedicle Screws, 135-Hybrids)
- Minimum 2-yr follow-up
- Radiographic measurements (AP, LAT, supine, side-bending)
- Preoperative (PreO), postoperative (PO), 1-yr and 2-yr follow-up



# Results

# Results

- Average age - 15.1 years
- Most frequent curve type
  - Lenke Type-1 (40.24%)
  - Lenke Type-3 (26.83%)
- Avg.MTC =  $59.29^\circ$  (PreO); corrected to  $18.58^\circ$
- TL/L curve =  $39.2^\circ$ ; corrected to  $12.9^\circ$
- PS  $\uparrow$  in both curves vs hybrids (73% vs. 65% and 71% vs. 64%)
- MTC - Hybrid lost sig. correction b/w PO and 1-yr FU (13.4%)
  - maintained that correction at 2-yr FU
- PS Group maintained its correction from PO-1-yr FU
  - lost some at 2-yr FU (3.8%)

# Results

- No sig. loss of correction (LOC)
  - At any time point in Lenke types 2-6
  - Lenke 1 curves showed LOC for both PS and H constructs
- TL/L curve
  - Only Hybrid group lost correction PO to 1-yr FU (9.7%).
- Sagittal C7 plumb and T12-S1
  - Both PS and H group lost some correction
    - PO and 1-yr FU ( $p < 0.001$  and  $p = 0.028$ )
    - Maintained that loss until 2-yr FU.
- T2-5 and T5-12
  - Only the H group lost correction over time

# Conclusions

1. Pedicle screws achieved better correction than hybrid constructs for all curve magnitudes.
2. Hybrid constructs lost significant correction for both the MT and TL/L curves at the 1-yr follow up point while pedicle screws maintained their correction.
3. The PS group maintained sagittal balance, while the Hybrid group lost minor correction.

# Accuracy and Efficacy of Thoracic Pedicle Screws in Curves over 90 Degrees

Timothy R. Kuklo, MD

Lawrence G. Lenke, MD

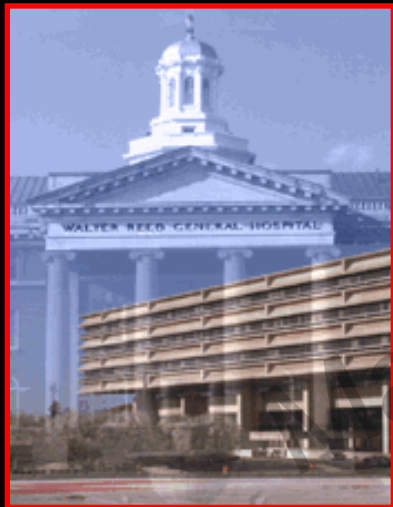
Ronald A. Lehman, Jr., MD

Michael O'Brien, MD

Spine 2004

\*Walter Reed Army Medical Center, Washington, D.C.

#Washington University School of Medicine, St. Louis, MO



# Introduction

Pedicle screw constructs are increasingly more common. However, the debate continues as to the safety and efficacy of these constructs due to their perceived increased risk for neurologic injury and the increased cost of spinal instrumentation.



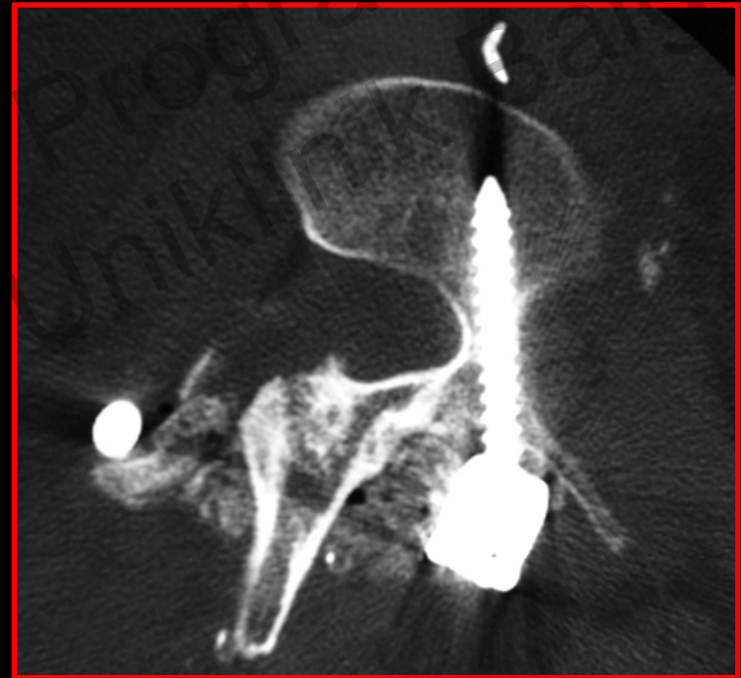
# Materials and Methods

- 19 pts. (22 curves  $> 90^\circ$ ) age 11-62 yrs
- Ave. F/U 2.7 yrs (8 mo – 4yr)
- Standard radiographic evaluation
- Comparison of preop plan with final construct to assess ability to place pedicle screws in severe deformity



# Materials and Methods

- Postop CT scanning to determine pedicle screw accuracy
- Graded as:
  - Intrapedicular
  - 0-2 mm breach
  - 2-4 mm breach
  - > 4 mm breach





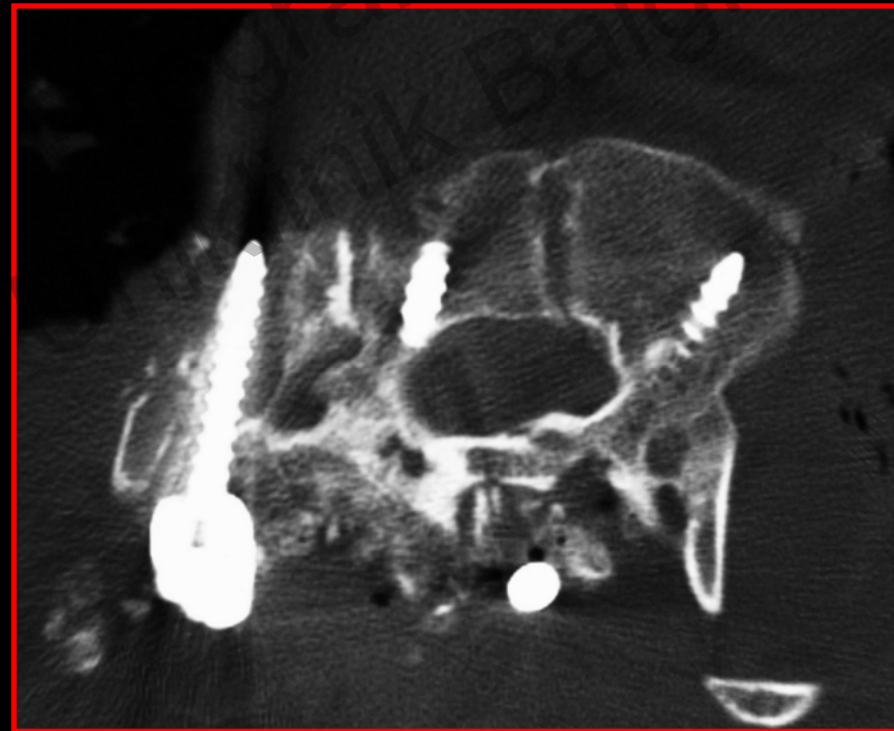
# Results

Average thoracic  
curve magnitude  
correction of 65  
degrees

<b>Preop MT</b>	<b>98.2°</b>
<b>MT SB</b>	<b>70.3°</b>
<b>P/O MT</b>	<b>32.9°</b>
<b>% Corr</b>	<b>67%</b>
<b>TL-L</b>	<b>62.7°</b>
<b>TL-L SB</b>	<b>37.2°</b>
<b>P/O TL-L</b>	<b>27.1°</b>
<b>% Corr</b>	<b>57%</b>

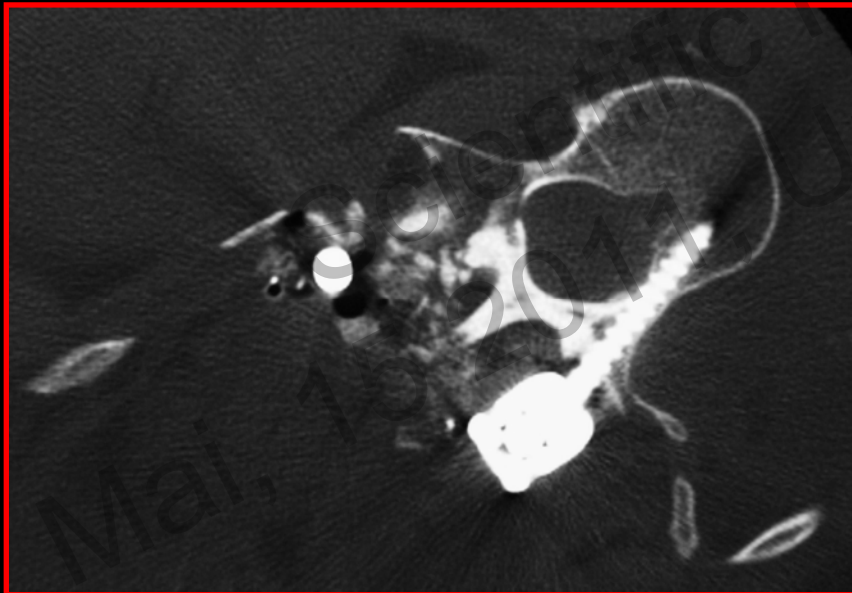
# Results

- Screw accuracy – 332 scanned screws
  - 321/332 were intrapedicular or  $< 2\text{mm}$  (**96.7%**)
  - 8/332 (**2.4%**) from 2-4 mm
    - 2 medial/4 lateral
  - 3/332 (**0.9%**)  $> 4\text{mm}$ 
    - 2 medial/1 lateral
    - 2 medial screws removed
- No neurologic deficits

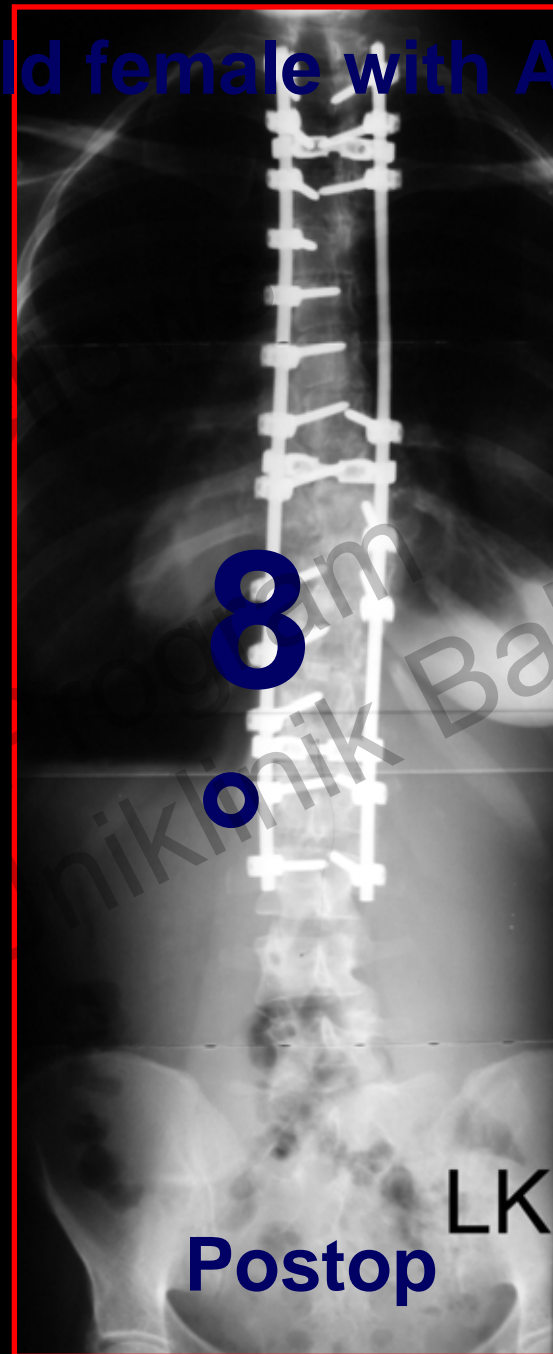


# Results

- Screw consistency –
  - 370/392 (94.4%) of thoracic pedicle screws placed according to preoperative plan



# Case 1: 16 year old female with AIS



# Clinical photographs



Preop

**S**

**B**

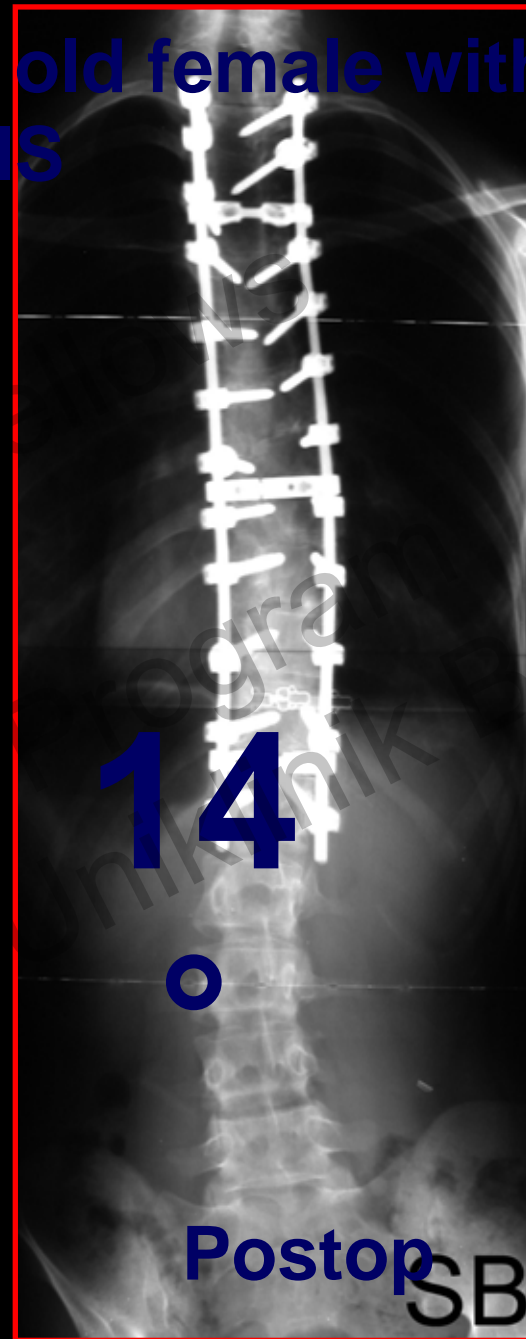
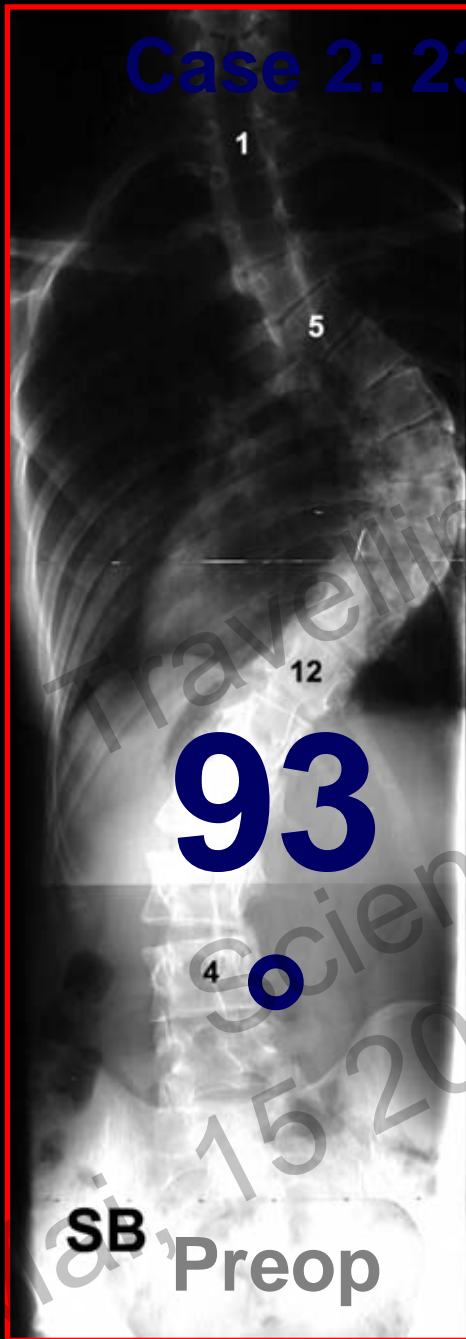


Postop

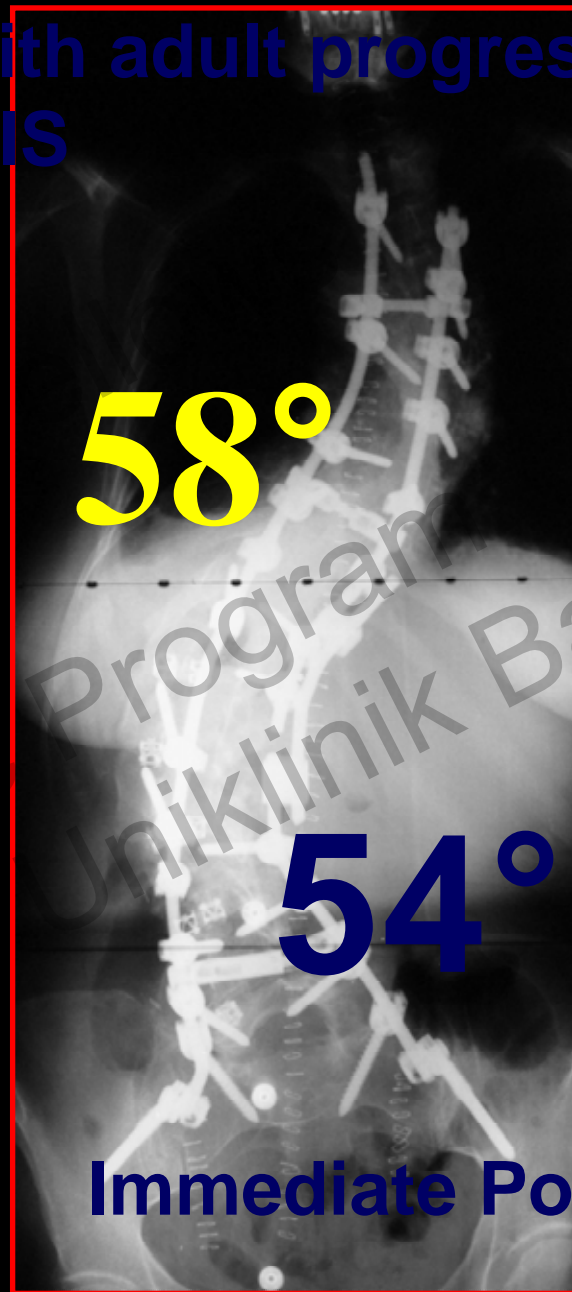
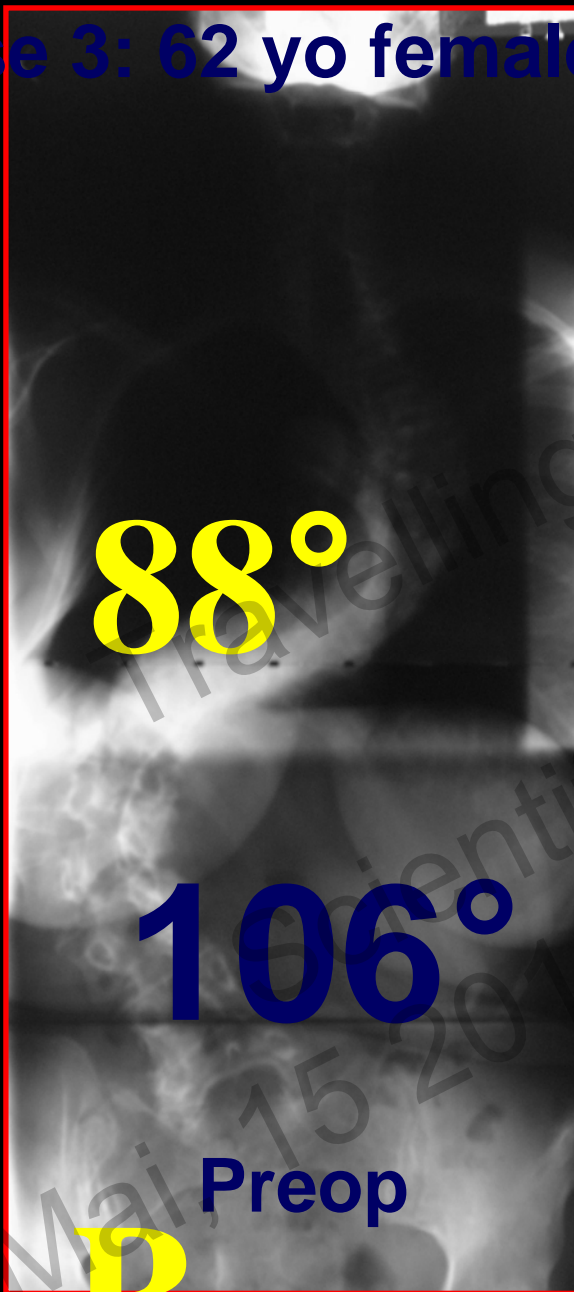
**S**

**B**

Case 2: 23 year old female with AIS



Case 3: 62 yo female with adult progression of AIS



Case 4: 44 yo female with adult progression





# Discussion

- Large magnitude curves ( $>90^\circ$ ) can be difficult to manage
- Convex compression may be ideal for *hypokyphotic* curve correction, and mandatory for *hyperkyphotic* curves

# Conclusions

- Thoracic pedicle screws provide powerful correction for these large magnitude curves
  - 65° average correction (**67%**)
- Screw accuracy excellent (**96.7%**)
- 94% of planned screws consistently placed according to the preoperative plan

# Thank You!

