

# Performing Safe Spinal Deformity Surgery: Strategies and Tactics

*Richard Menger MD MPA*

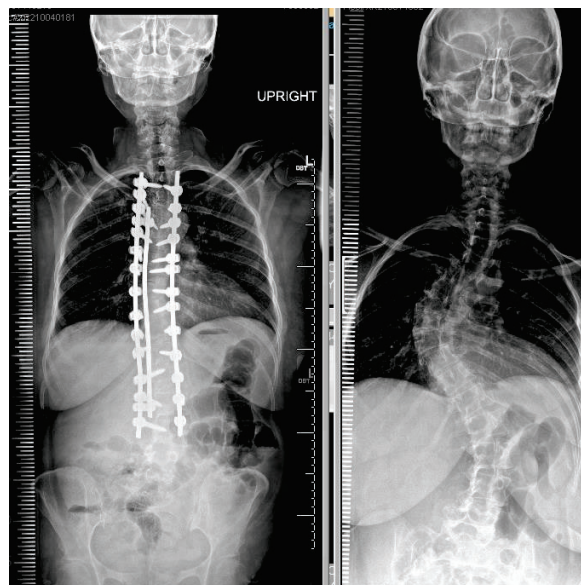
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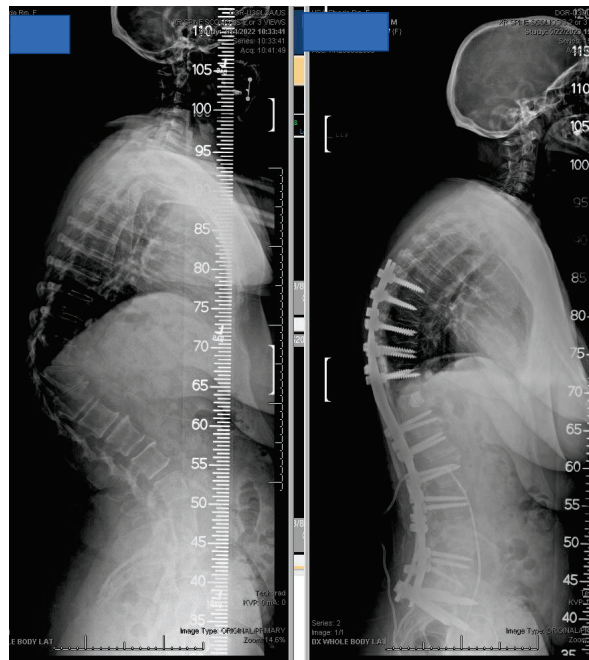


## Disclosures

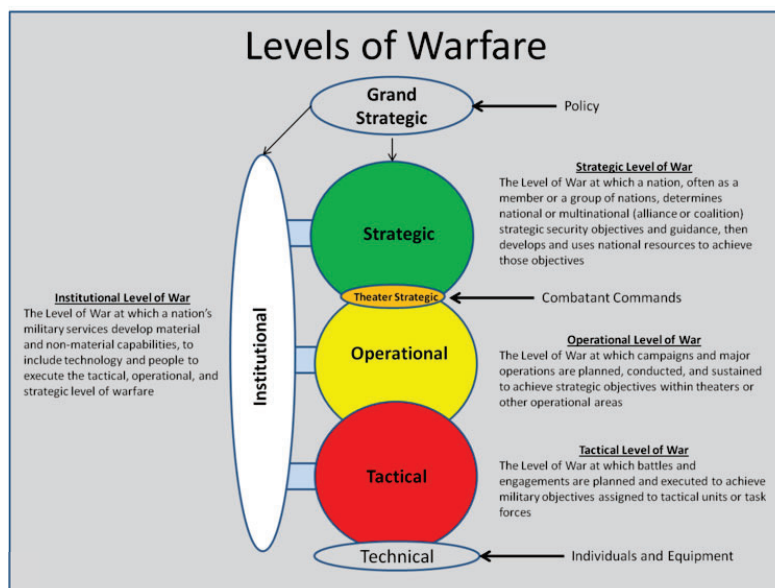
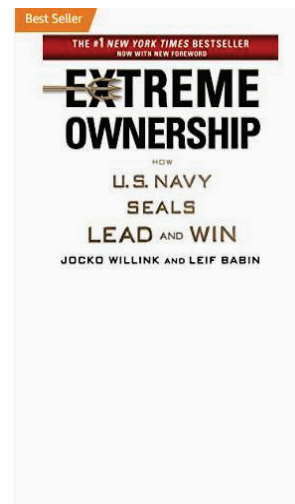
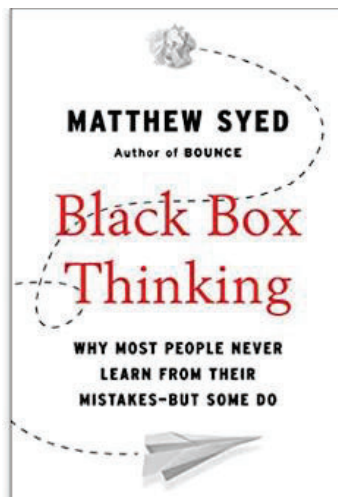
- Chief Medical Officer MS Logger
- Recipient of AEGIS Spine Socioeconomic Research Grant
- Co-founder Neurosurgical Advancement Foundation
- Faculty network member *Foundation for Economic Education*
- Does not represent views of the United States Navy, Department of Defense, or the United States

## Focus on Spinal Deformity





Complication Rates for these case are high



Adapted COL Daniel Sukman  
National Defense University

# Overview

Strategy:

Perform safest surgery with the least dose of surgery that will be tolerated for proper age-adjusted spinal alignment targeted for the patient's realistic long-term goals

Tactics:

- Individual steps and actions to get us there

## FOCUS ON WHAT AM I DOING DIFFERENTLY NOW IN 2023?

### Tactic 1: Achieve adequate spinal and pelvic fixation

- Need to know the basics or you can't do the surgery



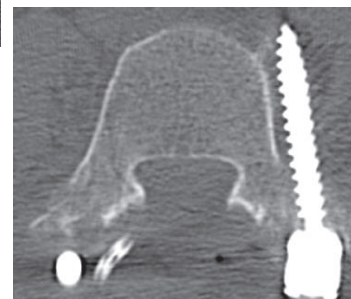
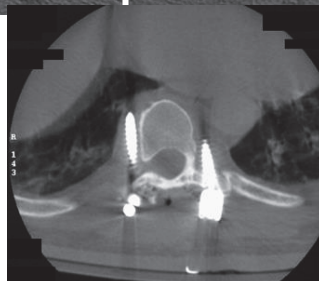
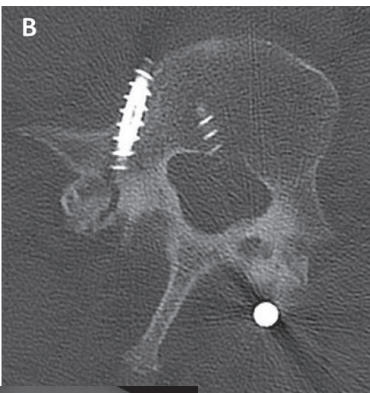
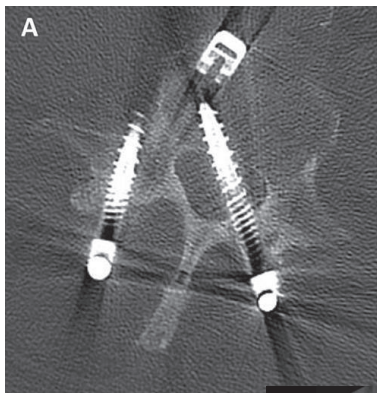
Spine (Phila Pa 1976). 2004 Feb 1;29(3):333-42; discussion 342.  
doi: 10.1097/01.brs.0000109983.12113.9b.

#### Free hand pedicle screw placement in the thoracic spine: is it safe?

Yongjung J Kim<sup>1</sup>, Lawrence G Lenke, Keith H Bridwell, Yongsun S Cho, K Daniel Riew

Affiliations + expand

PMID: 14752359 DOI: 10.1097/01.brs.0000109983.12113.9b





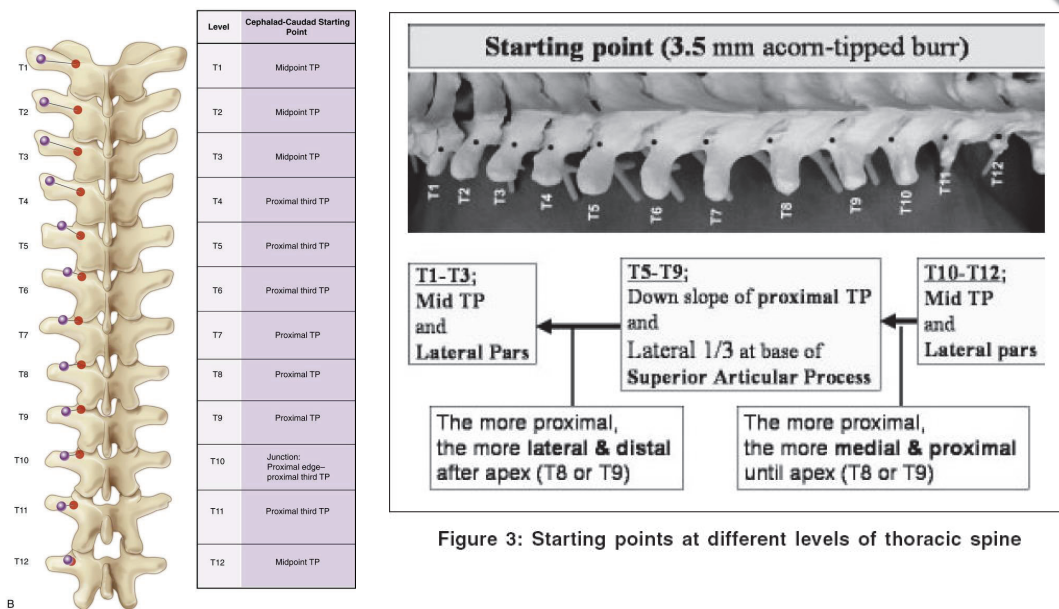


Figure 3: Starting points at different levels of thoracic spine

## Question?

- Is it safe for a young spine surgeon in 2023 to place freehand pedicle screws?

### Validation of Freehand Pedicle Screw Technique in a Deformity Trained Spine Surgeon Within the First Two Years of Practice

Maxon Bassett BS<sup>1</sup>, Patrick Young MD<sup>2</sup>, Richard Menger MD MPA<sup>3,4</sup>

<sup>1</sup>University of South Alabama Medical School, Mobile AL

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<sup>3</sup>Department of Neurosurgery, University of South Alabama, Mobile AL

<sup>4</sup>Department of Political Science, University of South Alabama, Mobile AL



# Methods

- Consecutive cases from a single surgeon within a single institution were investigated over a two-year period.
- Freehand pedicle screw success rates were compared to literature success rates regarding emerging technologies
- Demographic patient information, number of screws, and screw location was recorded from medical record, operative note, and x-ray respectively.
- Complications were reviewed and counted based on operative note and medical record
- Literature complication rates were reviewed and collected for comparison

## Results

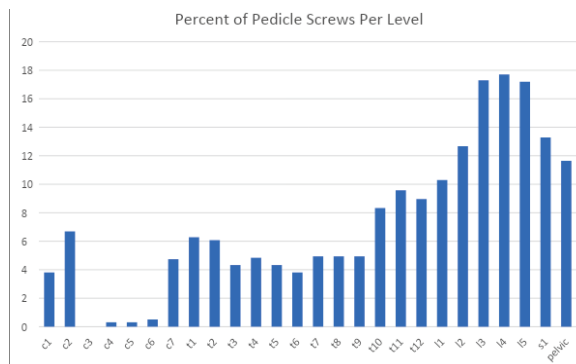
### Patient Demographics & Pedicle Screw Levels

Patient Information	Value
Number of patients	265
Mean Age	52.3
Male Sex %	55.50%
Average Blood Loss	411.2

Location	Number	Percent
Cervical	159	8.72
Thoracic	693	38
Lumbar	730	40.02
S1	129	7.07
Pelvic	113	6.2
Total	1824	100

## Results

### Pedicle Screws per Level



Location	Number	Percent
c1	37	3.81
c2	65	6.69
c3	0	0
c4	3	0.31
c5	3	0.31
c6	5	0.51
c7	46	4.74
t1	61	6.28
t2	59	6.08
t3	42	4.33
t4	47	4.84
t5	42	4.33
t6	37	3.81
t7	48	4.94
t8	48	4.94
t9	48	4.94
t10	81	8.34
t11	93	9.58
t12	87	8.96
l1	100	10.3
l2	123	12.67
l3	168	17.3
l4	172	17.71
l5	167	17.2
s1	129	13.29
pelvic	113	11.64
Total	1824	100

## Results

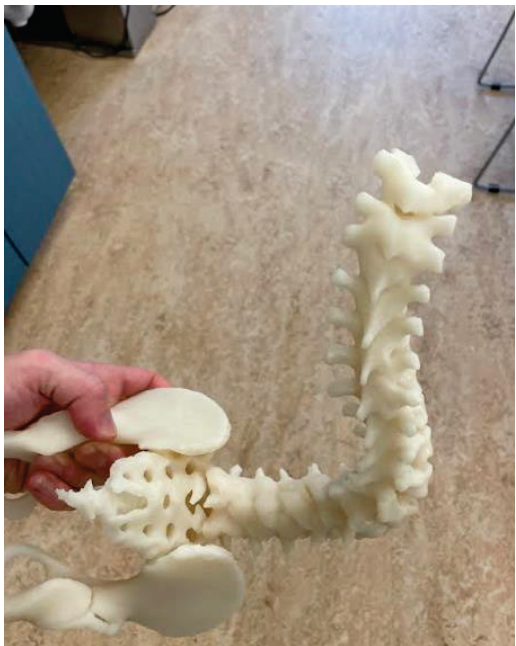
- 2 breached pedicle screws resulted in symptomatic complications
  - L5 pedicle screw with an inferior breach in a grade III spondylolisthesis case resulting in L5 radiculopathy
  - Breached iliac instrumentation with impingement on L5 nerve
- Both cases required revision surgery with symptomatic improvement

## Discussion

- Navigated pedicle screw complication rates range from 0- 6.8%
- Leading meta-analysis shows an average complication rate of 1.13%

Source	Year	Patients	Complications	Comp %
Staartjes et al	2018	3449	31	0.9
Tang et al	2014	2323	1	0.04
Tarawneh et al	2021	266	3	1.13
Van de Kelft et al	2012	347	8	2.31
Total		6385	43	0.67



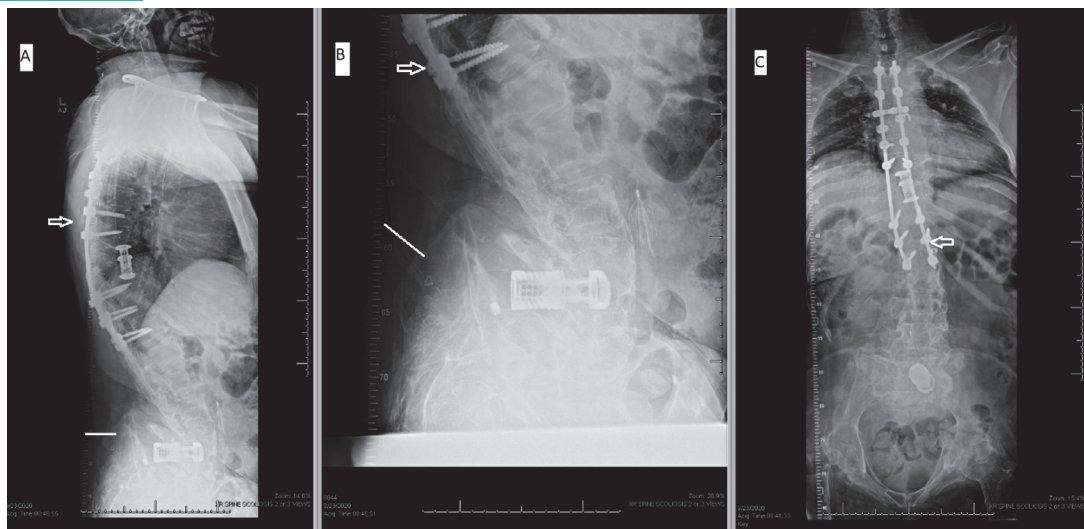


## Pelvis Fixation

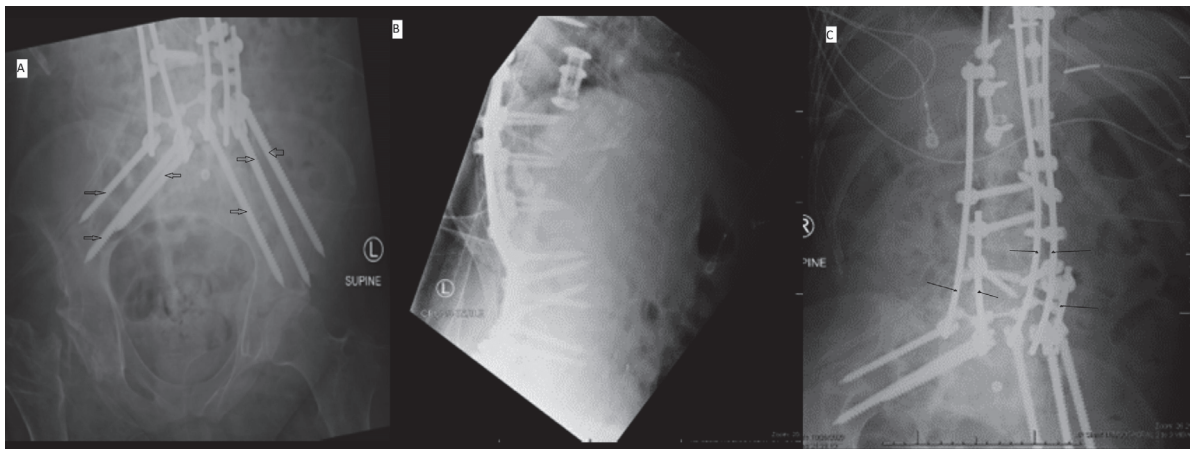
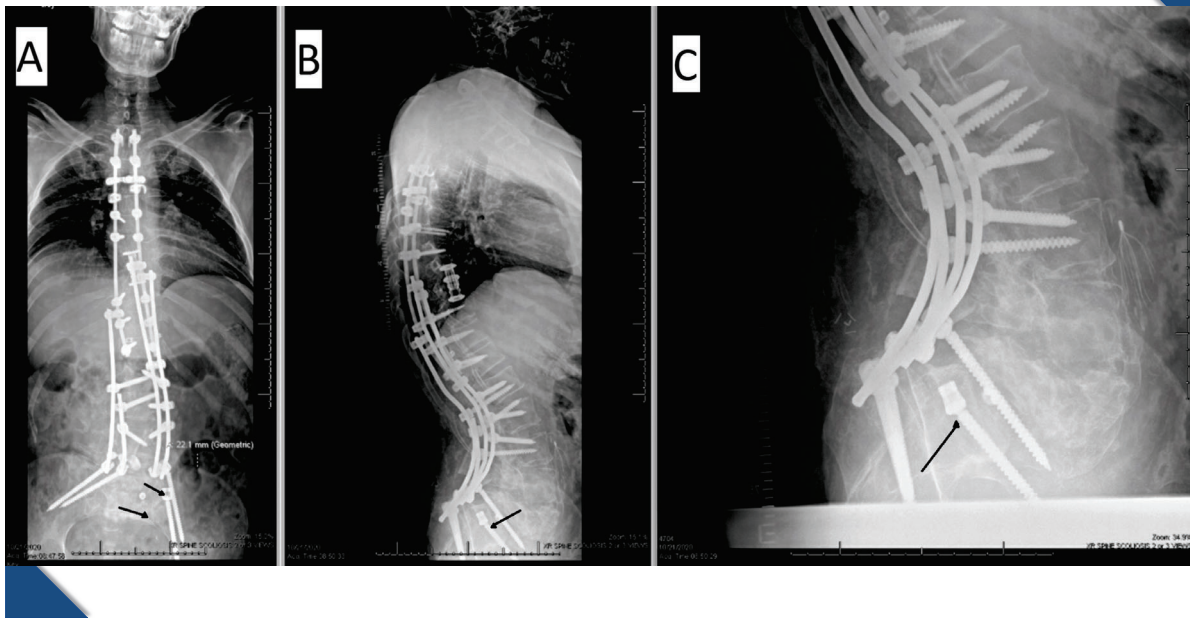
- I now use:
- Four points of pelvic fixation
- Multiple rod constructs
- Open sacroiliac fusion via the SI=Granite Fusion Device



Rella, Trent, Menger et al 2022



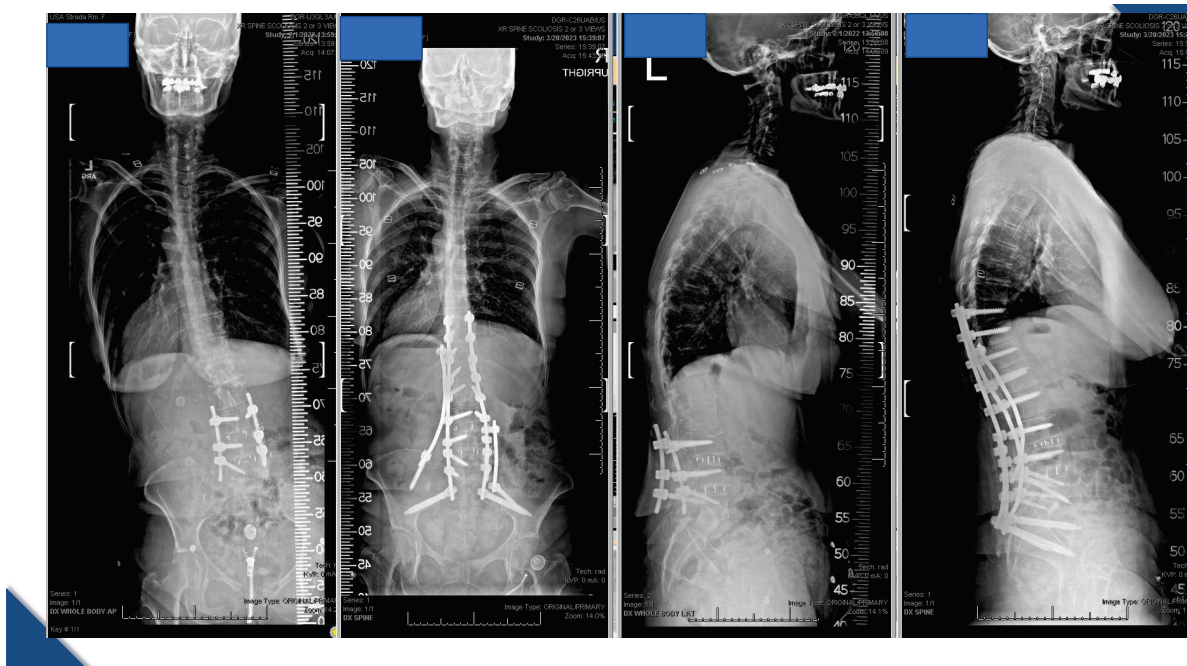




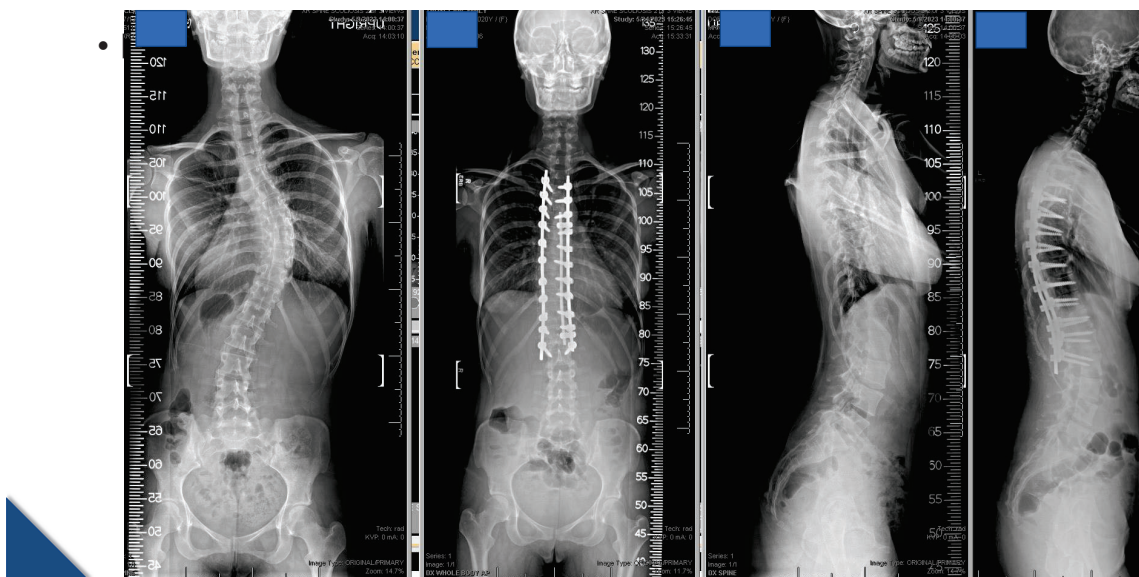
## Fusion to the pelvis and SI Joint

- 24% lumbopelvic fixation failure of ASD patients (Eastlack et al in *Spine* 2022)
- 12% SI joint pain after S2AI and iliac screws (Elder et al 2017)
- 33% SI joint patient after multilevel degenerative spine surgery (Finger et al 2016)
- Re-operation rates for these surgeries 16-26%





## Tactic # 2: Reduce blood loss



## Tactic 2: Reduce blood loss

- Relax MAP during opening ~60
- Considering relaxing the patient during opening (TEVA)
- Two bovies
- Relaxing portions of the wound
- High dose TXA (50mg/kg loading dose and 5mg/kg maintenance)
- Cell saver
- Meticulous hemostasis

- If you lose control of the case you when to exit the case.

Spine Deform. 2018 Mar-Apr;23(2):189-194. doi: 10.1016/j.jspd.2017.08.007. Epub 2017 Nov 2.

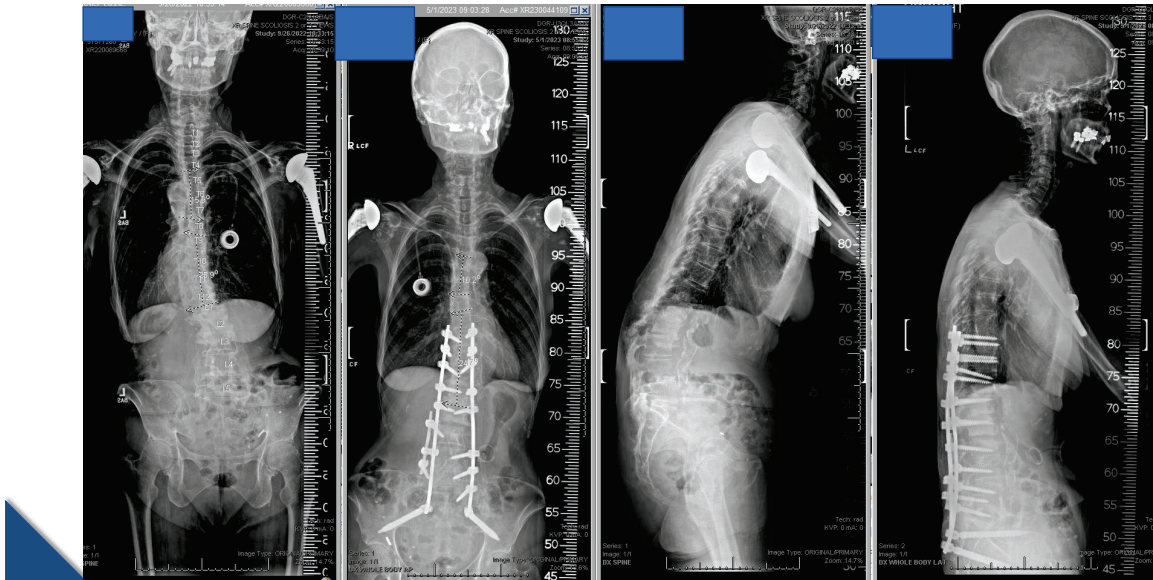
### Safety of a High-Dose Tranexamic Acid Protocol in Complex Adult Spinal Deformity: Analysis of 100 Consecutive Cases

James D Lin <sup>1</sup>, Lawrence G Lenke <sup>2</sup>, Jamal N Shillingford <sup>3</sup>, Joseph L Laratta <sup>4</sup>, Lee A Tan <sup>5</sup>, Charla R Fischer <sup>3</sup>, Mark A Weller <sup>3</sup>, Ronald A Lehman Jr <sup>1</sup>

Affiliations + expand



## Tactic # 3: Reduce infection



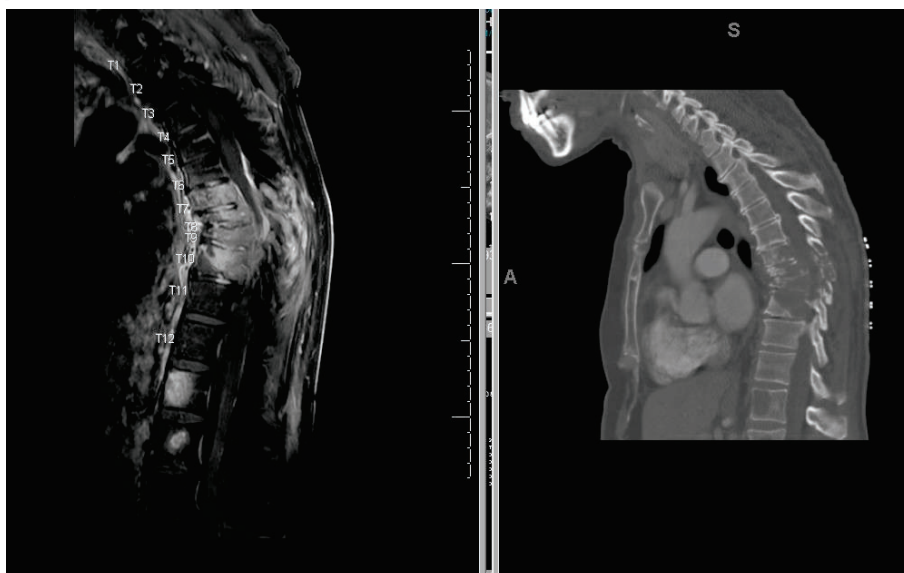
## Tactic # 3: Reduce infection

- Cascade of care pre-op, intra-op, and post-op
- Nutritional labs, plastic surgery labs
- Plastic surgery closure
- Antibiotics
- Changing gloves
- Movement to antibiotic beads

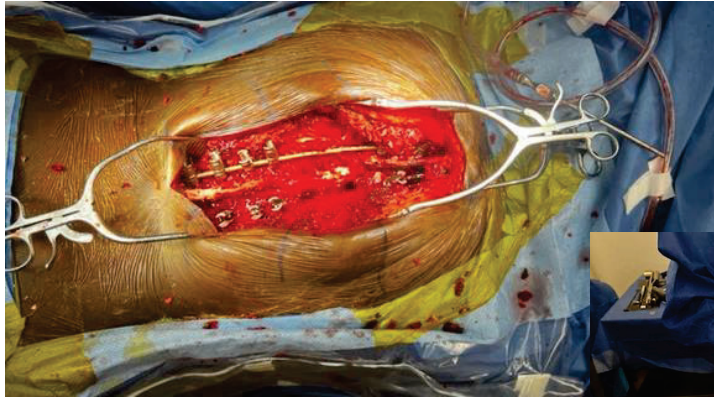
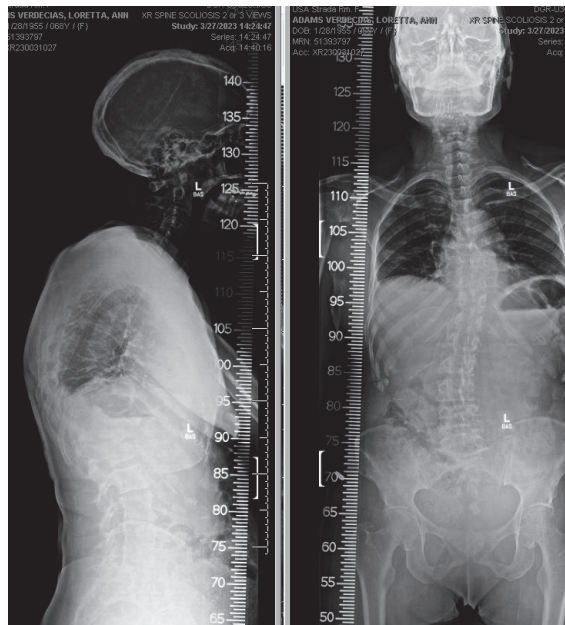
### Building Consensus: Development of a Best Practice Guideline (BPG) for Surgical Site Infection (SSI) Prevention in High-risk Pediatric Spine Surgery

Michael G. Vitale, MD, MPH\* Matthew D. Riedel, BA\* Michael P. Glotzbecker, MD,†  
 Hiroko Matsumoto, MA\* David P. Royce, MD\* Behrooz A. Akbarnia, MD,‡  
 Richard C.E. Anderson, MD, FACS, FAAP§ Douglas L. Brockmeyer, MD,||  
 John B. Emans, MD,† Mark Erickson, MD,¶ John M. Flynn, MD,##  
 Lawrence G. Lenke, MD,\*\* Stephen J. Lewis, MD,†† Scott J. Luhmann, MD,\*\*  
 Lisa M. McLeod, MD, MSCE‡‡ Peter O. Newton, MD,§§  
 Ann-Christine Nyquist, MD, MSPH,|||¶¶ B. Stephens Richards, III, MD,###  
 Suken A. Shah, MD,\*\*\* David L. Skaggs, MD,††† John T. Smith, MD,‡‡‡  
 Paul D. Sponseller, MD, MBA,§§§ Daniel J. Sucato, MD,###  
 Reinhard D. Zeller, MD,|||| and Lisa Saiman, MD, MPH¶¶¶###

## Type 3: Reduce Infection







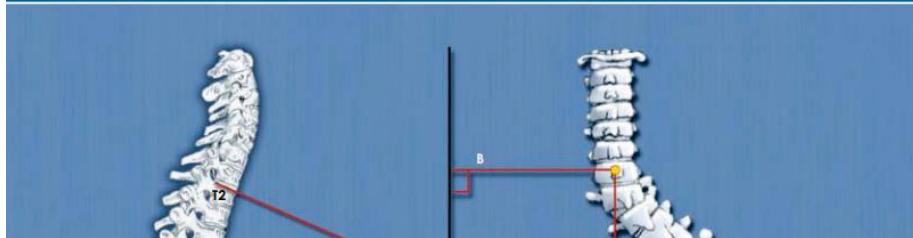
## Tactic # 4: Obtain proper alignment

Spinal Deformity Study Group

# Radiographic Measurement Manual

### Editors in Chief

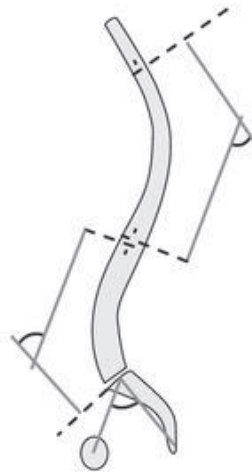
Michael F. O'Brien, MD  
Timothy R. Kuklo, MD  
Kathy M. Blanke, RN  
Lawrence G. Lenke, MD



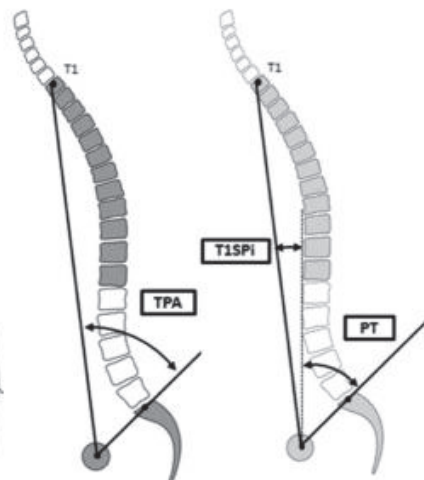
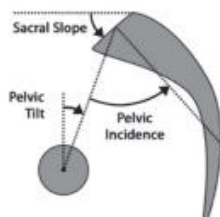
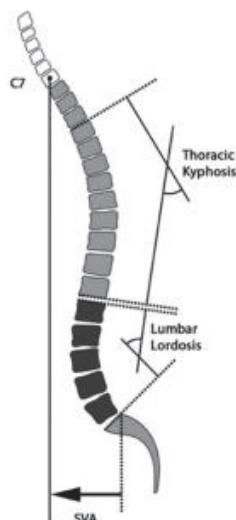
SVA < 50 mm



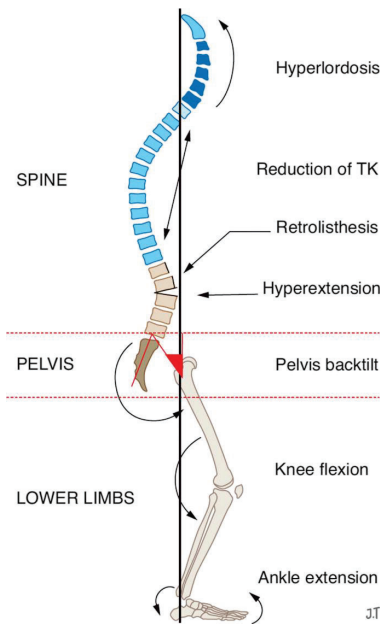
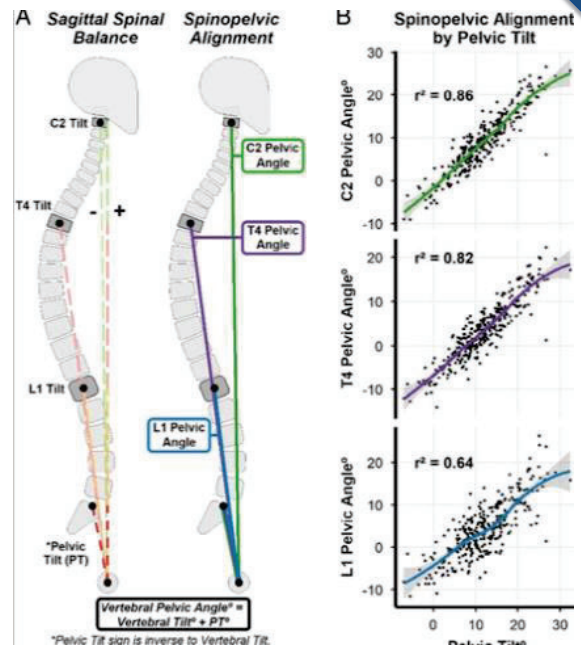
PT < 20°



Spino-pelvic harmony  
LL = PI  $\pm$  9°



# T4-L1 Hip Axis



## AdS Classification

### 1. Curve Type (1-6)

Type	Proximal Thoracic	Main Thoracic	Thoracolumbar/Lumbar	Description
1	Non-Structural	Structural (Major)	Non-Structural	Main Thoracic (MT)
2	Structural	Structural (Major)	Non-Structural	Double Thoracic (DT)
3	Non-Structural	Structural (Major)	Structural	Double Major (DM)
4	Structural	Structural (Major)	Structural (Major)	Triple Major (TM)
5	Non-Structural	Non-Structural	Structural (Major)	Thoracolumbar/Lumbar (TL/L)
6	Non-Structural	Structural	Structural (Major)	Thoracolumbar/Lumbar-Main Thoracic (TL/L-MT)

Major = Largest Cobb measurement

Curve types from Lenke AIS classification<sup>1</sup>

#### Structural Criteria

Proximal Thoracic (PT): Supine Cobb  $\geq 35^\circ$  OR T2-T5 kyphosis  $\geq 20^\circ$

Main Thoracic (MT): Supine Cobb  $\geq 35^\circ$  OR T10-L2 kyphosis  $\geq 20^\circ$

Thoracolumbar/Lumbar (TL/L): Supine Cobb  $\geq 35^\circ$  OR T10-L2 kyphosis  $\geq 20^\circ$

### 2. Lumbosacral Modifier (NS, S)

**NS** (Non-Structural): Lumbosacral Supine Cobb  $< 20^\circ$

**S** (Structural): Lumbosacral Supine Cobb  $\geq 20^\circ$

### 3. Global Alignment Modifier (Aligned, Cor Malalign, Sag Malalign, Combined Malalign)

**Aligned**: SVA and CVA less than 40mm

**Sag Malalign** (sagittal malalignment): SVA  $\geq +40$  mm

**Cor Malalign** (coronal malalignment): CVA  $\geq +4$ cm OR CVA  $\leq -4$ cm

**Comb Malalign** (combined sagittal and coronal malalignment): SVA  $\geq +40$  mm AND (CVA  $\geq +4$ cm OR CVA  $\leq -4$ cm)

Curve Type	Description
1	Main Thoracic (MT)
2	Double Thoracic (DT)
3	Double Major (DM)
4	Triple Major (TM)
5	Thoracolumbar/Lumbar (TL/L)
6	Thoracolumbar/Lumbar-Main Thoracic (TL/L-MT)

Structural criteria: always structural criteria applied to be major curve

#### APLX

T2-T11/T12 Disc

T12-L1

L1/L2 Disc-L4

#### Sagittal Profile T5-T12

ypo)  $< 10^\circ$

mmal)  $10^\circ - 40^\circ$

yper)  $> 40^\circ$

lier (-, N, +) =

3

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Fig. 1 Overview of the three-component AdS classification



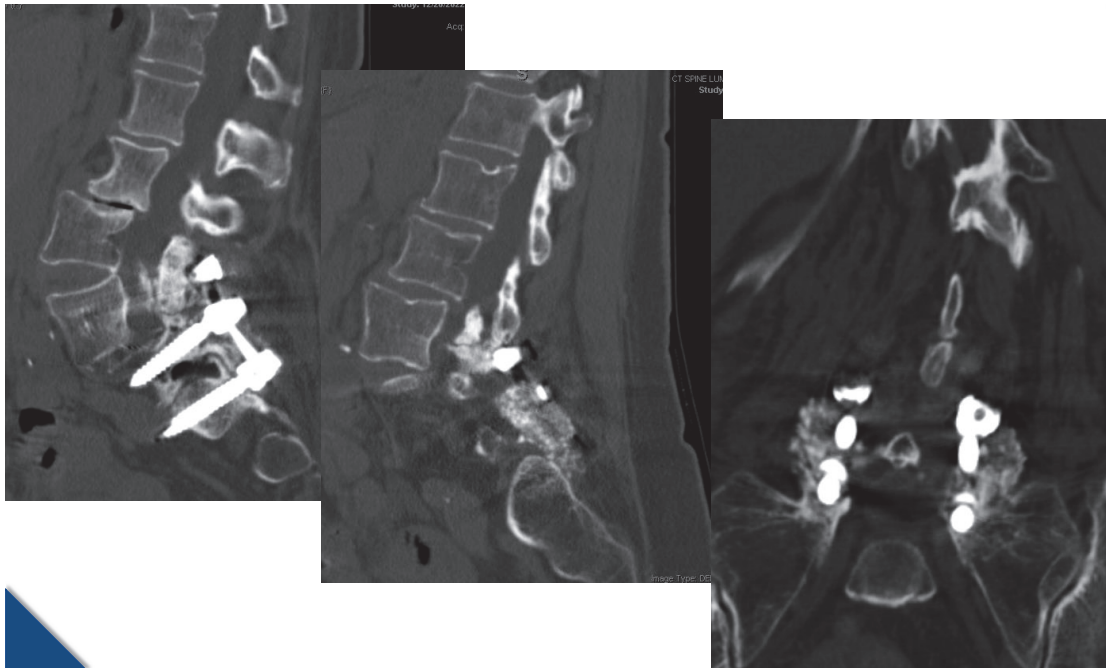
# Case Example

## LM

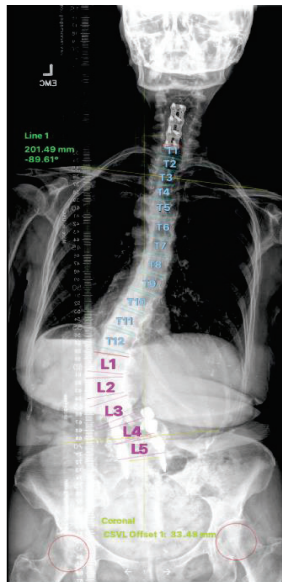
- HPI
  - 74F
  - Back pain > leg pain for a period of years, some relief lying flat
  - Failed PT and ESI
  - Strongly desires surgical correction
  - No formal osteoporosis diagnosis
- PMH: No heart attack, no anti-coag, no stroke, no DM
- PSH: L4-S1 lami/fusion w L4-5 TLIF
- SH: Does not smoke, well-educated, married
- FH: Non-contrib

- X-ray
  - Globally well balanced sag plane age adjusted
  - Coronally < 4cm with 34 deg w apex at L5
  - PI 57 deg
  - PI-LL mismatch <10 deg but this is due to proximal compensation
  - ~2/3 of LL from L1-3.
- CT:
  - L4-5 pseudoarthrosis
  - L4-S1 post-lat fusion
  - Vacuum disc L2-3 and retro
  - HF units at L1 are 92

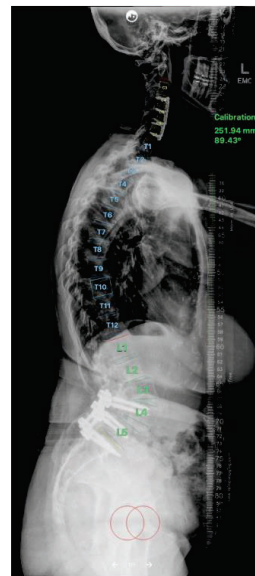




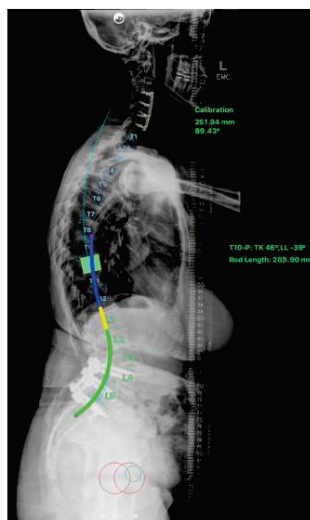
## BACS System



MEASURE	PRE-OP
C7PL	35.02 mm
Pelvic Obliquity	-5.37°
Clavicle Angle	8.05°
Sacral Obliquity	-3.38°
T1 Tilt	9.98°
MC: Cobb	-45.96°
MC: Type	L
MC: Apex	L1-L2
MC: Apex Deviation	-45.31 mm
MC: Upper/Lower	T10sup-L3inf
SC: Cobb	21.73°
SC: Type	MT
SC: Apex	T7-T8
SC: Apex Deviation	-20.29 mm
SC: Upper/Lower	T5sup-T10inf
TC: Cobb	-12.58°
TC: Type	PT
TC: Apex	T3-T4
TC: Apex Deviation	-13.15 mm
TC: Upper/Lower	T2sup-T5inf
CSVL Offset 1	33.48 mm
L4 Sup Width	44.74 mm



MEASURE	PRE-OP	NORM
UIV	T10	
PT	17.66°	14.8 to 25.6
PI	62.18°	62.18°
S5	44.52°	35.4 to 48.6
LL	-63.65°	-64.9 to -47.1
L1-L4	-46.63°	-34.6 to -19.8
L4-S1	-29.42°	-39.2 to -27.2
PI-LL	-1.47°	-3.7 to 12.9
L1-S1	176.52 mm	
TL	7.32°	-7.7 to 6.9
TK	52.51°	32.8 to 51.4
T2-T5	8.11°	
T5-T12	45.42°	
T9 SPI	-8.48°	-14.5 to -8.3
T1 SPI	1.92°	-5.8 to -0.6
TPA	19.58°	11.1 to 22.7
T1-L1	292.77 mm	
T1-S1	469.30 mm	
SVA (C7S1)	77.02 mm	-0.1 to 62.7
PJK	17.76°	

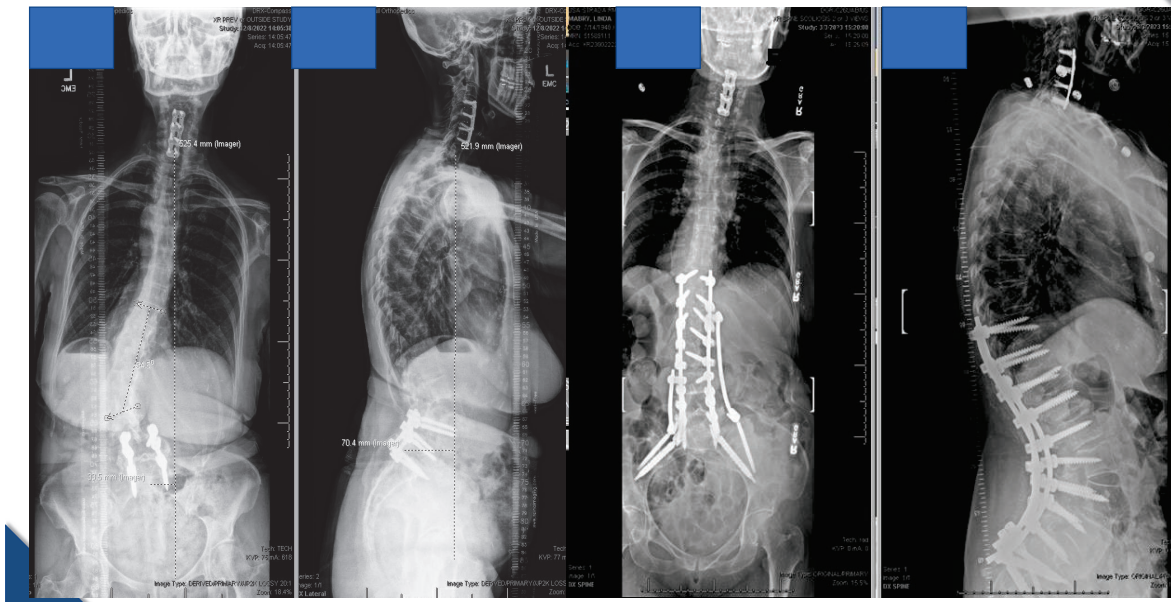


T10-P: TK 46°, LL -39°

UIV	T10
Pre Adjustment PJK Value	17.76°
LIV	S2
Pre Adjustment DJK Value	nan°
Thoracic Bend Angle	46.00°
Adjusted Thoracic Bend Angle	46.00°
Lumbar Bend Angle	-39.00°
Adjusted Lumbar Bend Angle	-39.00°
Thoracic Radius	333.80 mm
Thoracic Segment	109.35 mm
Thoracic Chord Length	108.86 mm
Transition Length	35.89 mm
Lumbar Radius	112.07 mm
Lumbar Segment	143.66 mm
Lumbar Chord Length	134.02 mm
Rod Length	288.90 mm

# Surgery

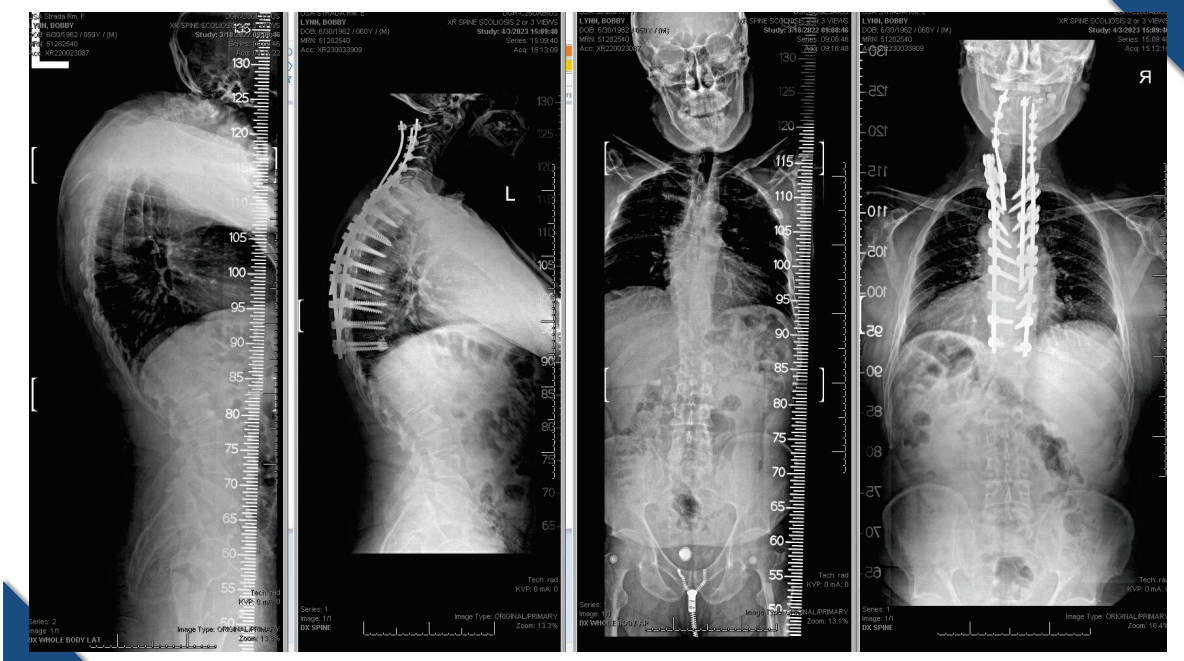
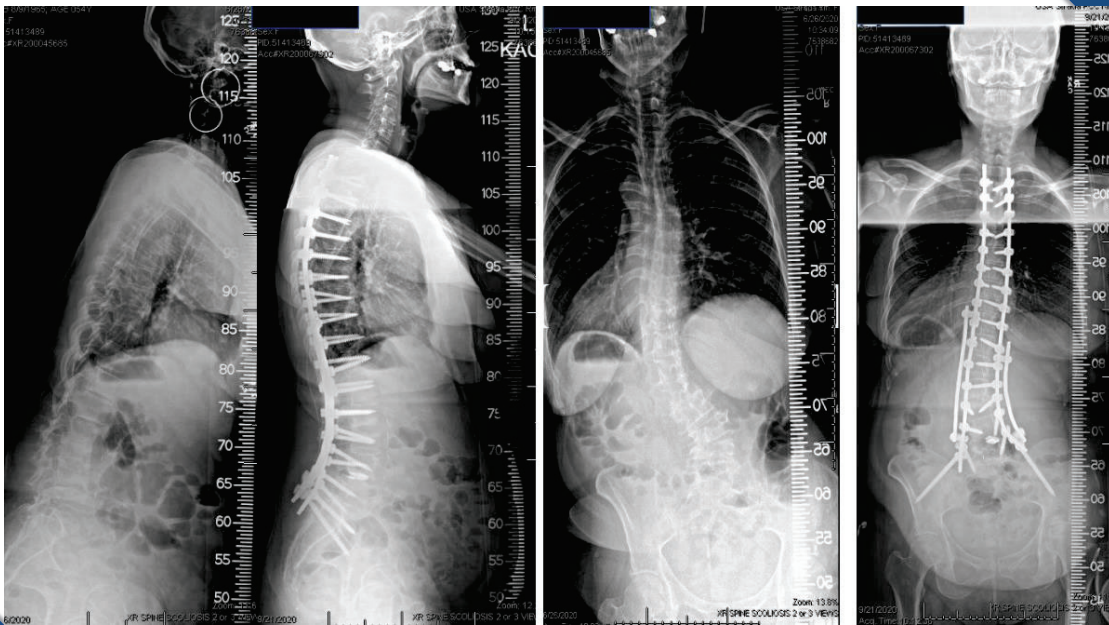
- T10-pelvis instrumentation and fusion L2-3 and L3-4 posterior column osteotomy and L3-4 laminectomy with tethering T9-10-11



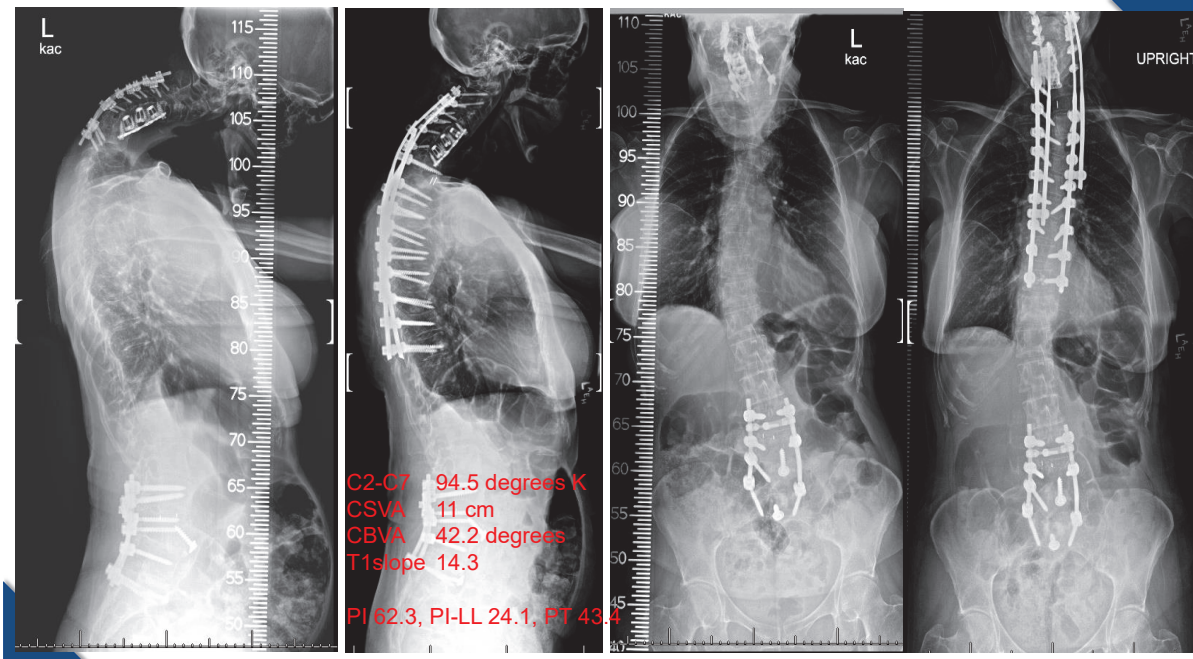
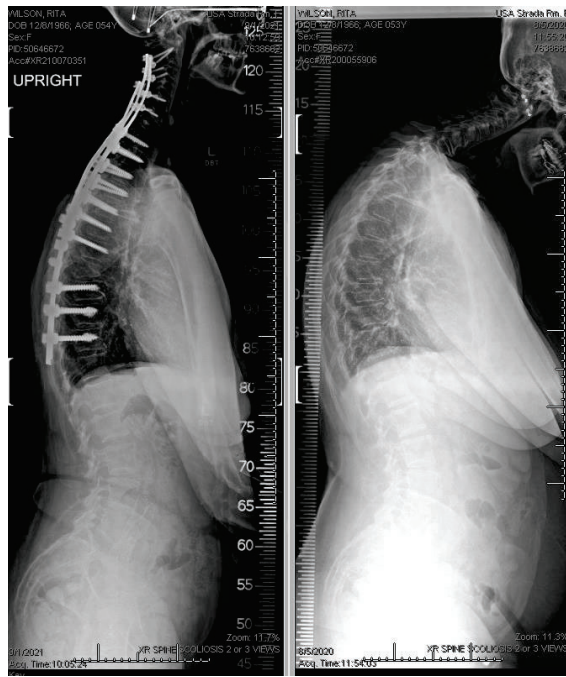
## Tactic 5: Do the Right Surgery

In 2023, previously unfused adult patients without congenital deformity almost never need a three column osteotomy









# Tactic 6: Prepare yourself and your team to handle spinal deformity

[Global Spine J.](#) 2017 May; 7(3): 280–290.

Published online 2017 Apr 7. doi: [10.1177/2192568217699203](#)

PMCID: PMC5476358

PMID: [28660112](#)

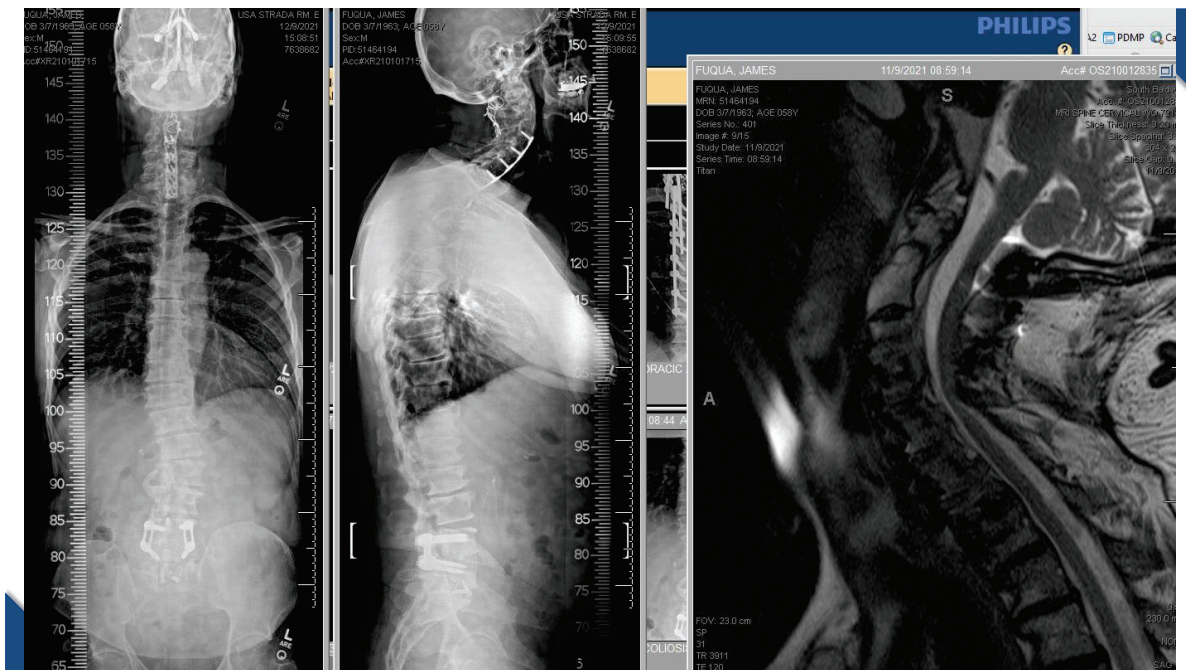
## Vertebral Column Resection for Rigid Spinal Deformity

[Comron Saifi](#), MD,<sup>1</sup> [Joseph L. Laratta](#), MD,<sup>1</sup> [Petros Petridis](#), BS,<sup>1</sup> [Jamal N. Shillingford](#), MD,<sup>1</sup> [Ronald A. Lehman](#), MD,<sup>1</sup> and [Lawrence G. Lenke](#), MD<sup>1</sup>

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## Integrative “spinal deformity”

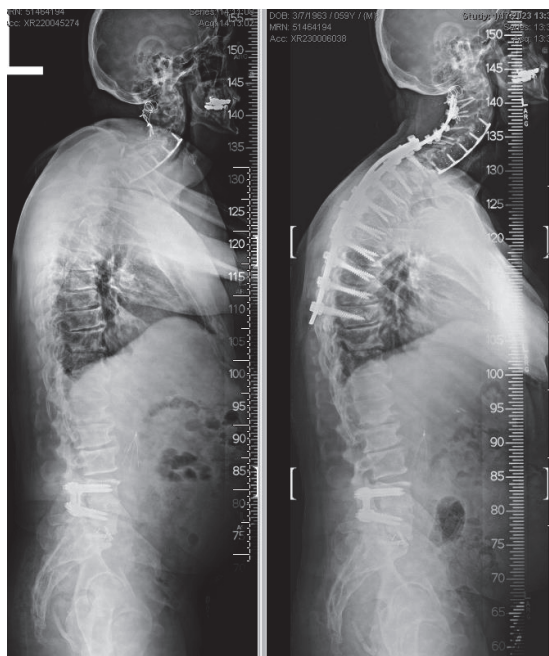
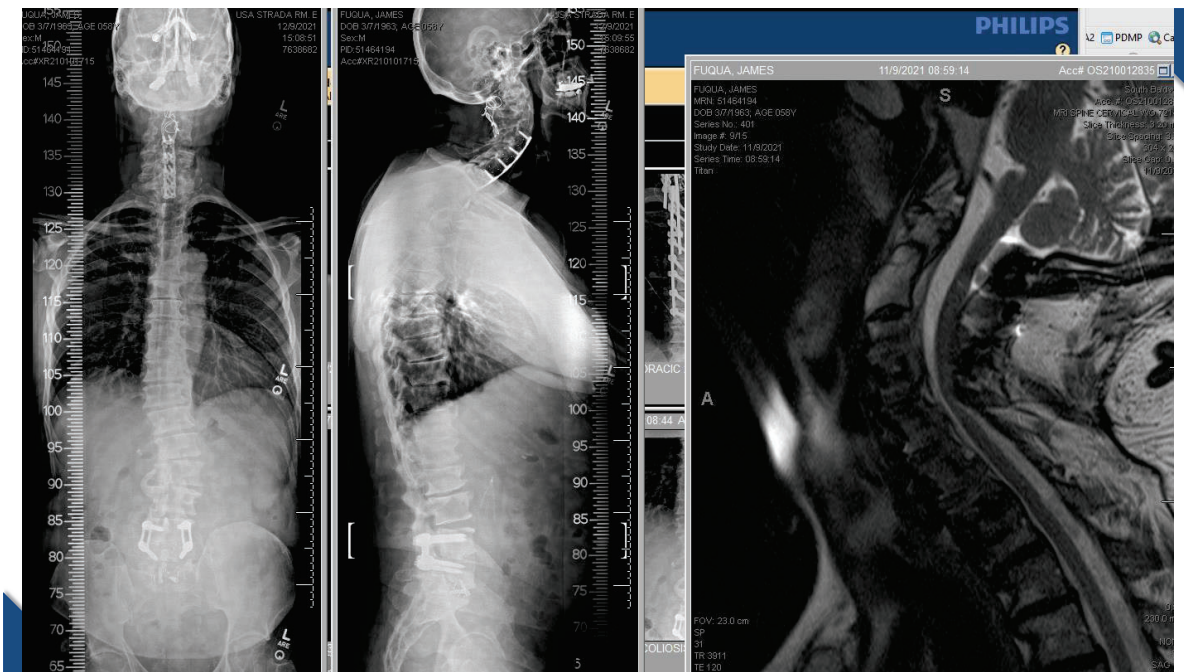
- Pre-op
- Clinic infrastructure
- Family interaction
- Outcomes
- OODA loop
- Emotional burden for patient
- Emotional burden for family
- Emotional burden for team
- Emotional burden for surgeon

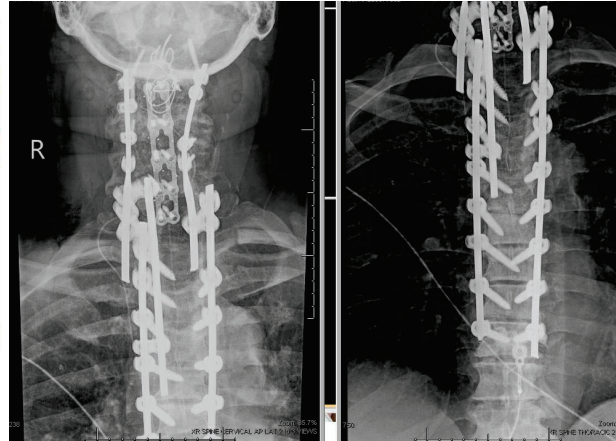
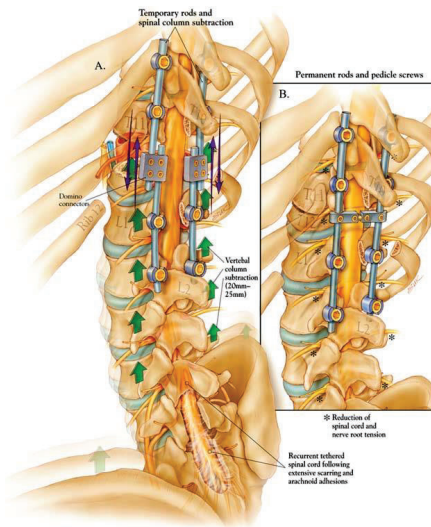




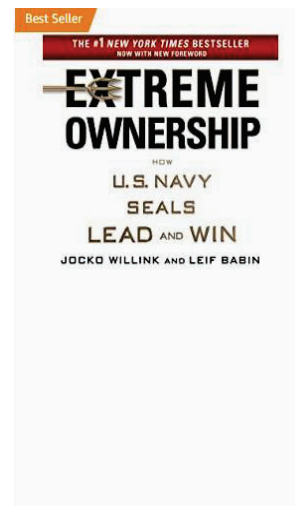
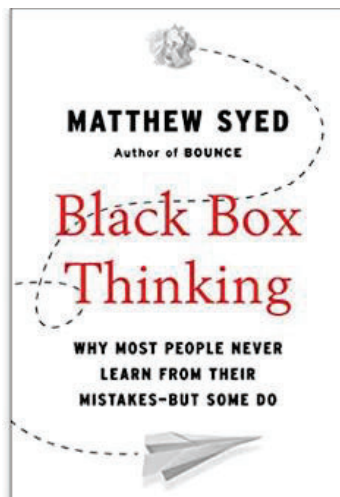


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Conclusion:



Questions?

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