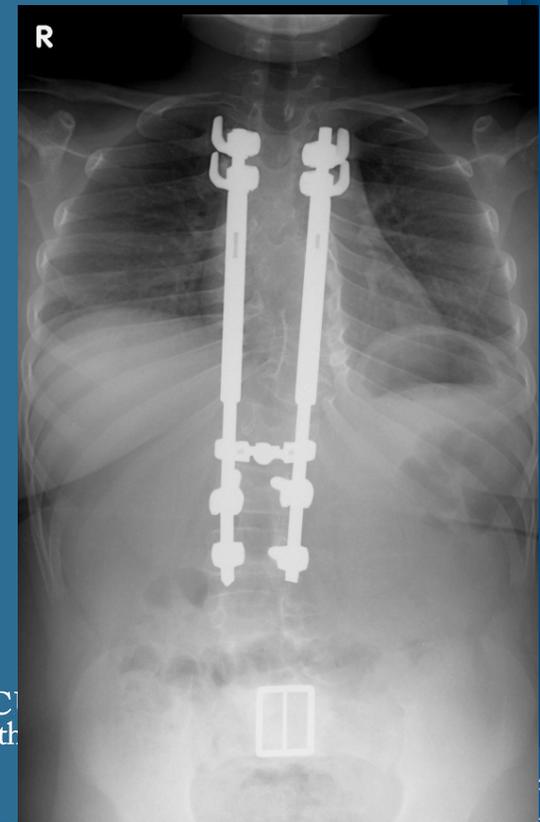
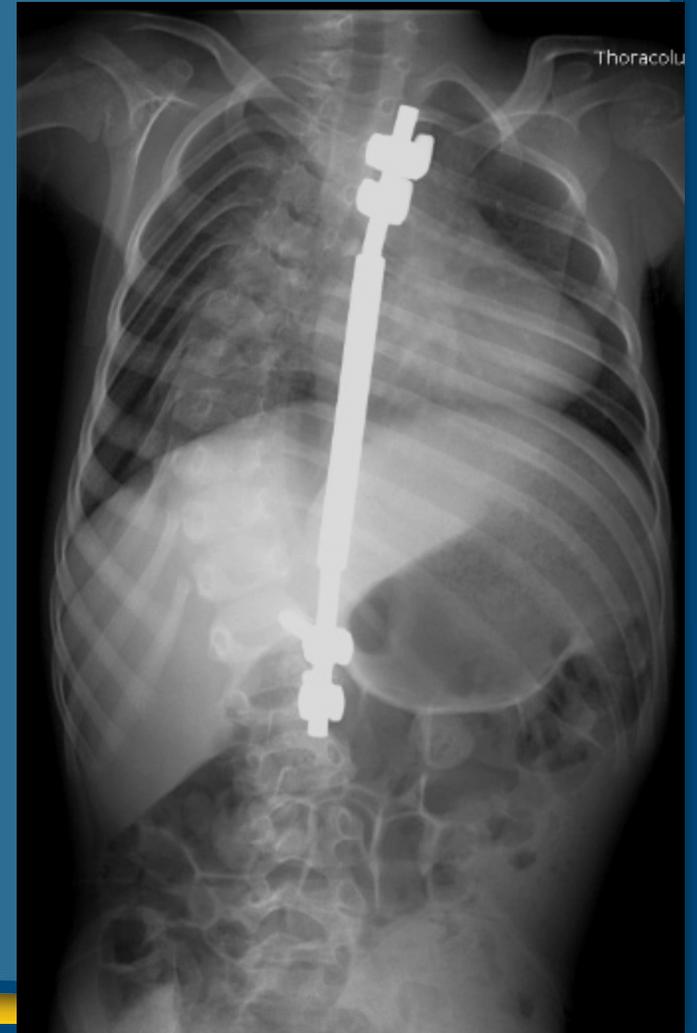


# Masters Techniques: Rib Anchored Distraction Based Growing Rods

David L. Skaggs, MD  
Professor and Chief  
Children's Hospital Los Angeles  
University of Southern California



# Use of Spine Hooks on Ribs NOT FDA Approved



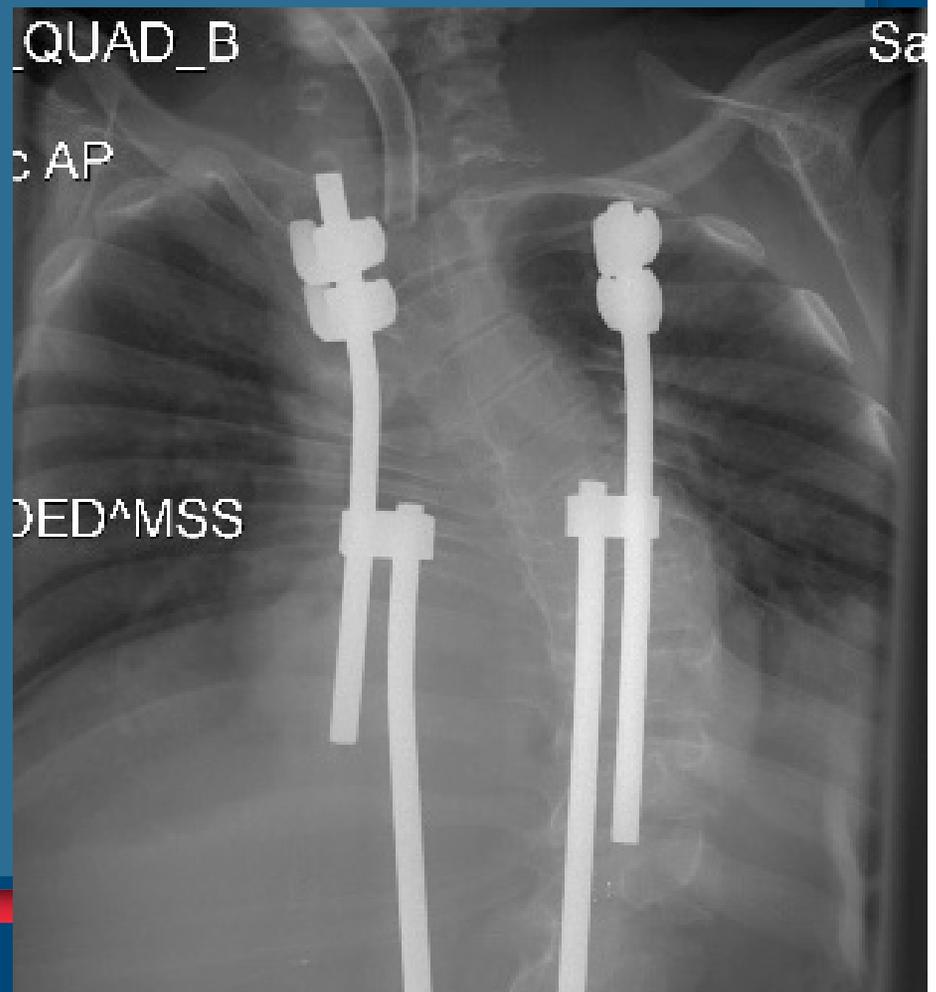
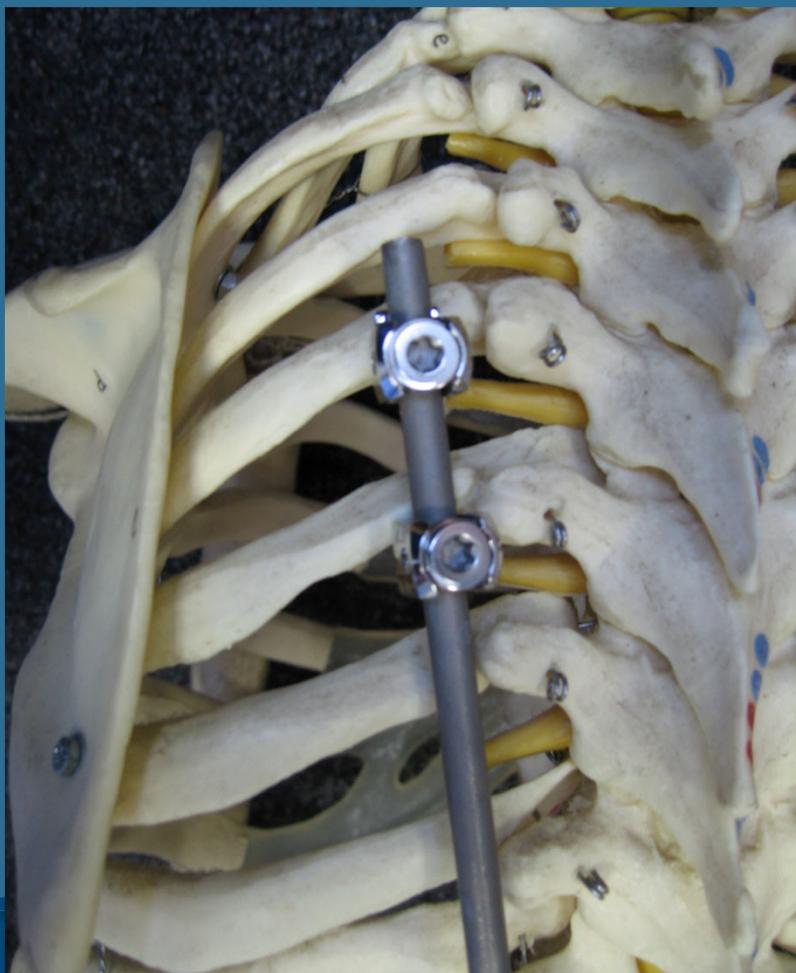
# Part 1: Theoretical Advantages



# Hooks on Ribs: No intentional fusion

## Do not expose or fuse upper spine

### No thorocotomy!

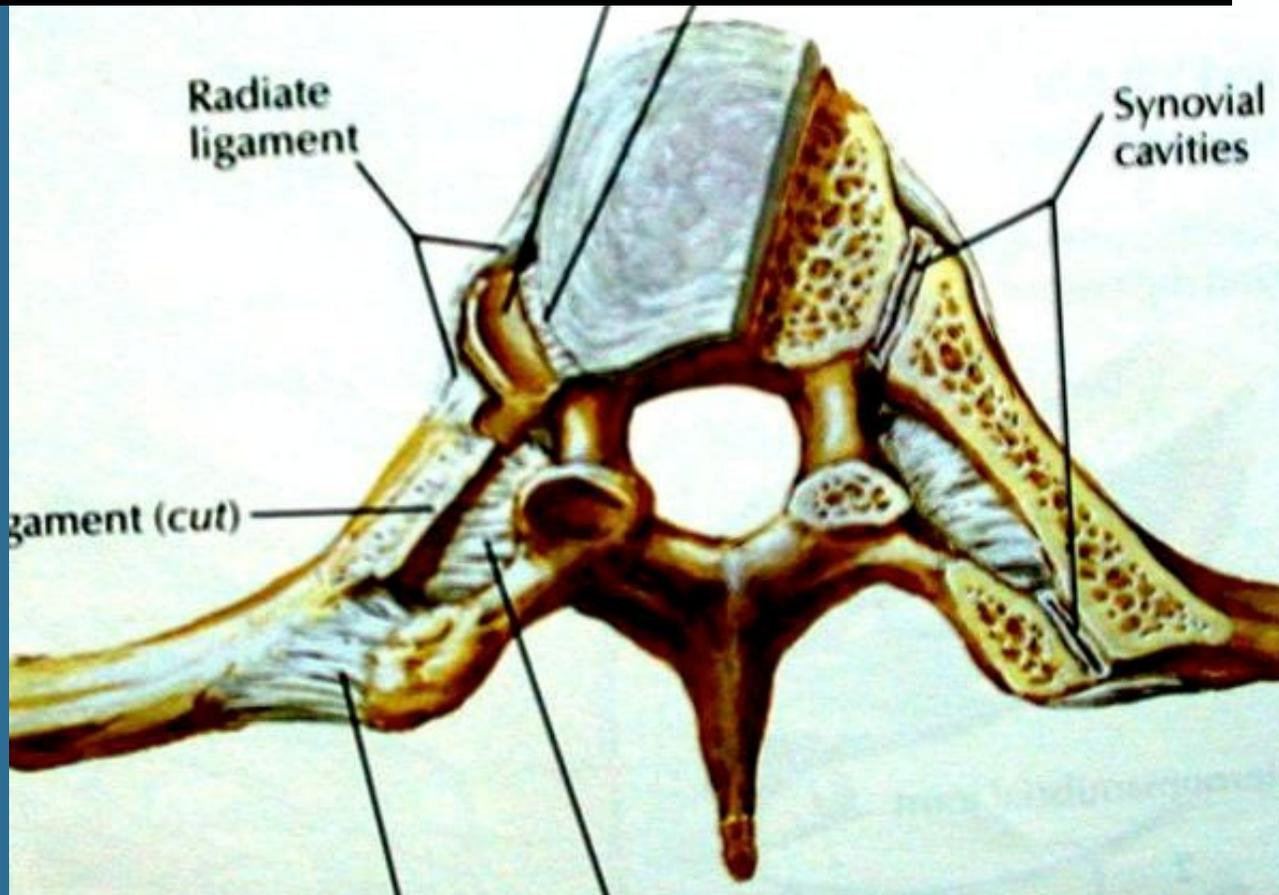


# Traditional Growing Rods Cause Autofusion

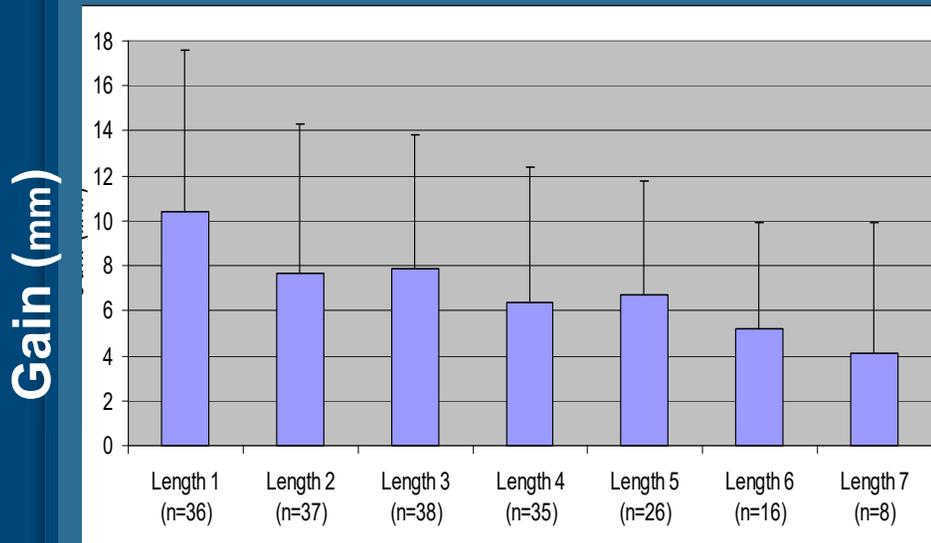
Cahil, et. Al, Spine 2010

- 8/9 patients autofused - Stiff Curves!
- Growing rods in for 7 yrs
- Mean of 7 osteotomies done at final fusion
- 44% Cobb Angle correction

- Movement of the ribs joints
- “slop” of the hooks
- ?= less autofusion

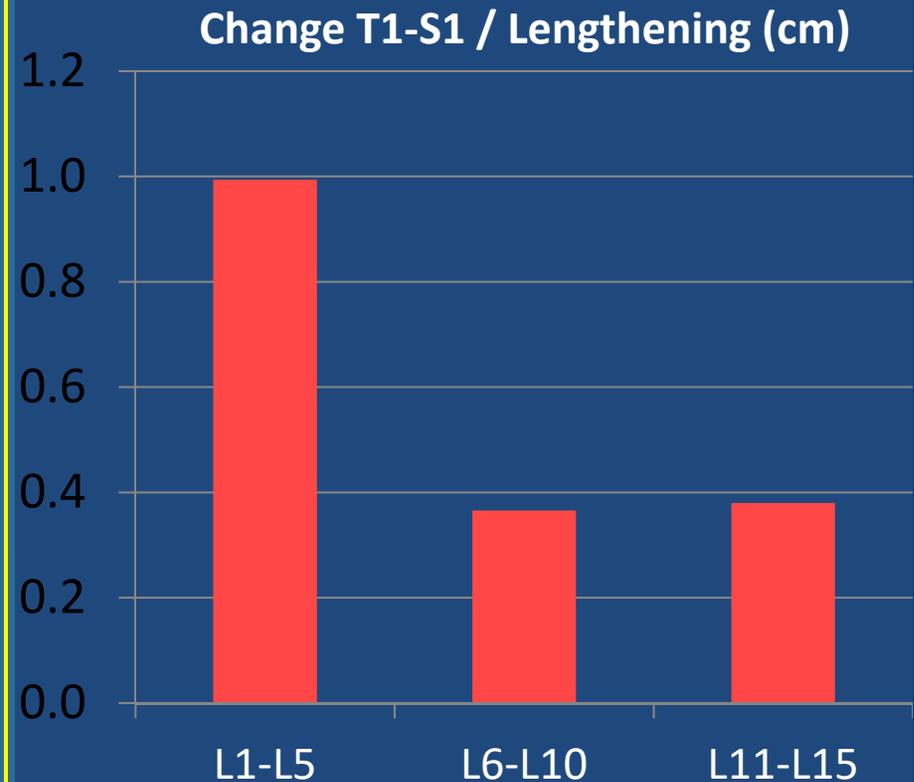


# Traditional Growth Rods Get Stiff Over Time



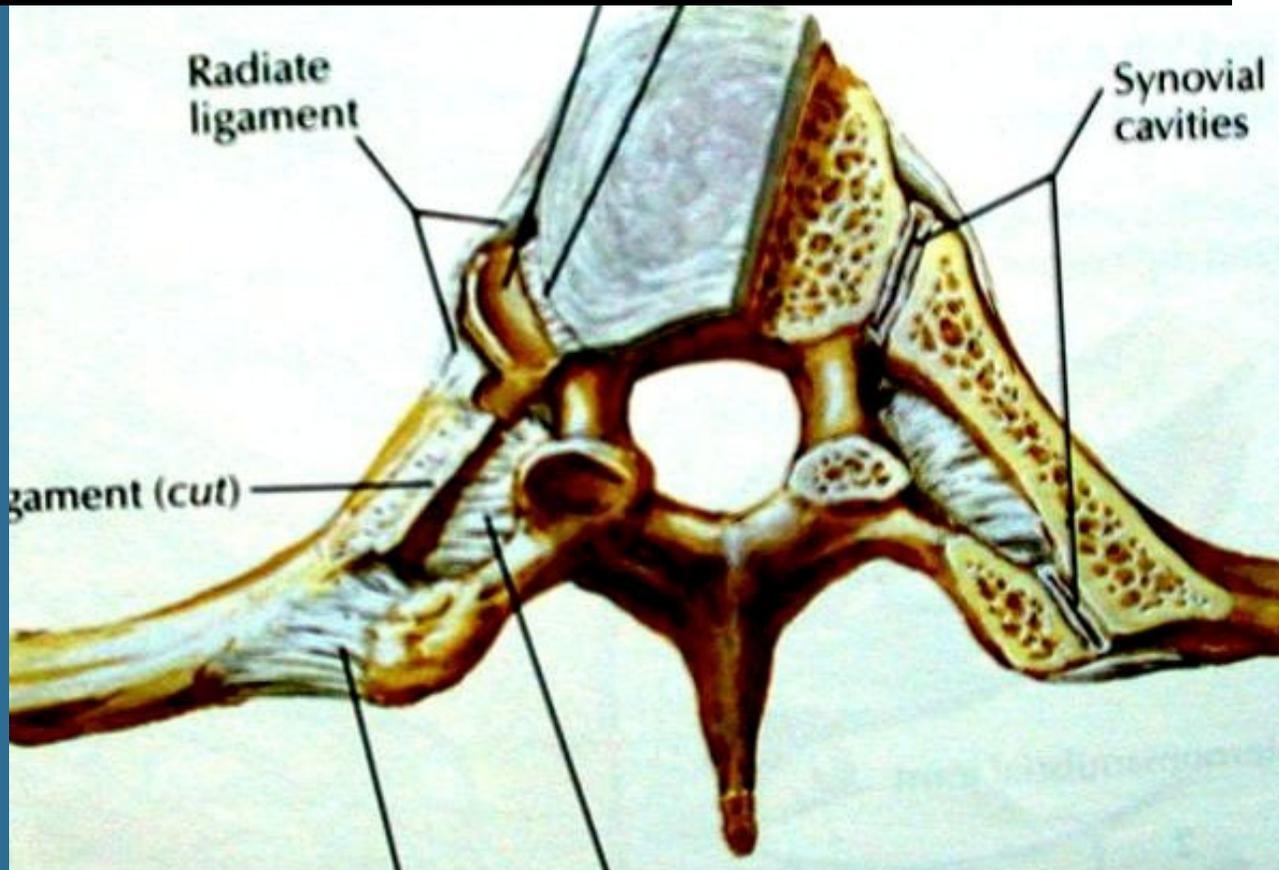
T1-S1 Gain vs. # of Lengthenings

# ? Smaller Effect with rib anchors?



**But continued gain even  
at L11-L15**

- Movement of the ribs joints
  - “slop” of the hooks
- ?= Less likely to break rods



- Movement of the ribs joints
  - “slop” of the hooks
- ?= Less likely to break rods

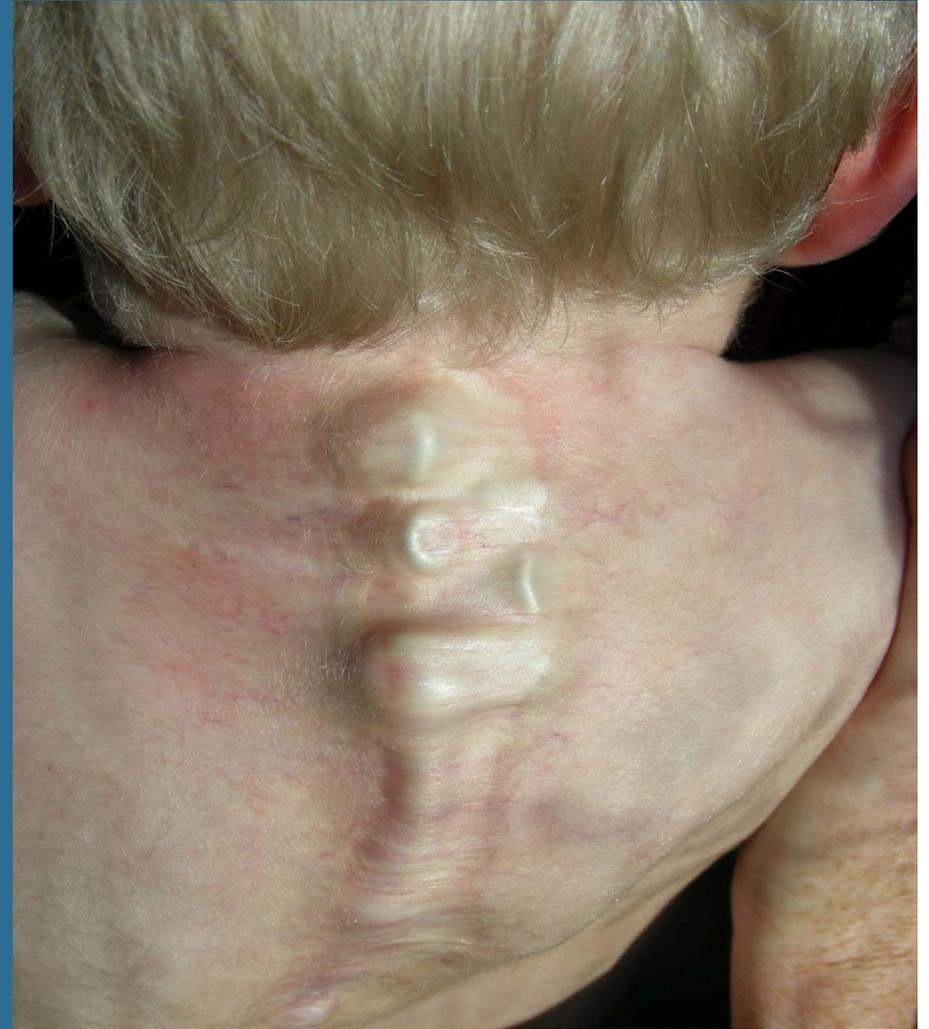


GSSG Study – 176 pts, 56 month f/u  
rib anchored growing rods 77%  
less likely to break rods than  
spine anchored



# Nutrionally Depleted Population

- Soft tissue Coverage Challenging
- 47% pts pre-op failure to thrive (<5 percentile)



Myung, 2009

# Low Profile

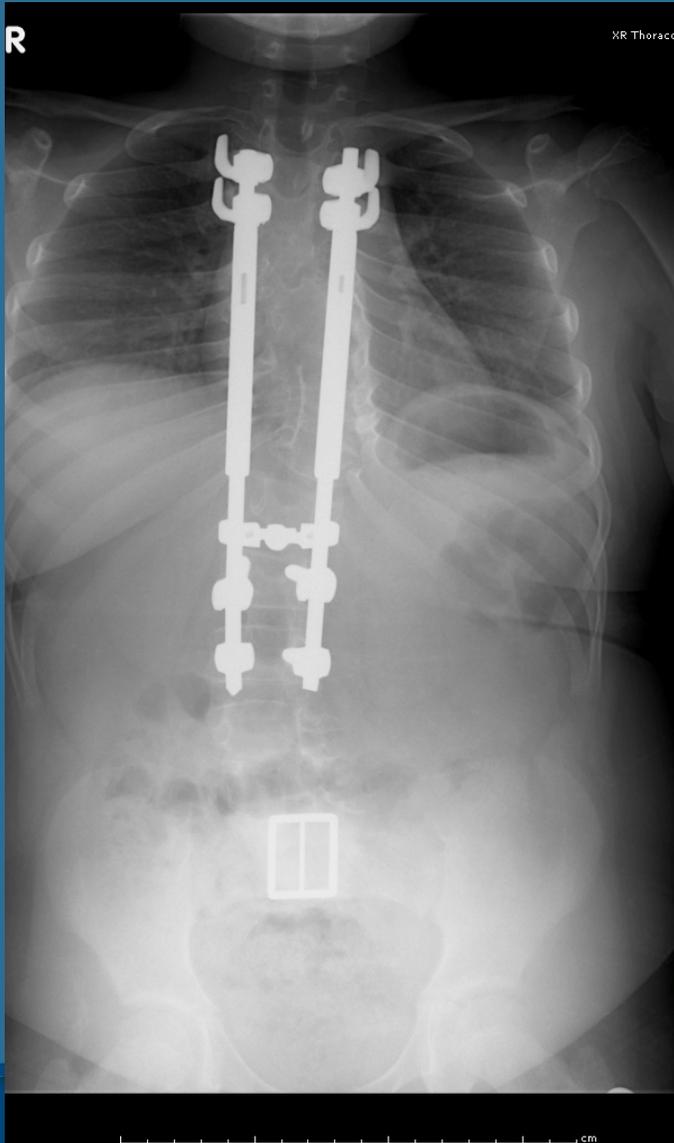


## Rib based anchors better for PJK?

- Hybrids 42% (5/12) Vs. Growing rods 62% (10/17)
  - P=0.059

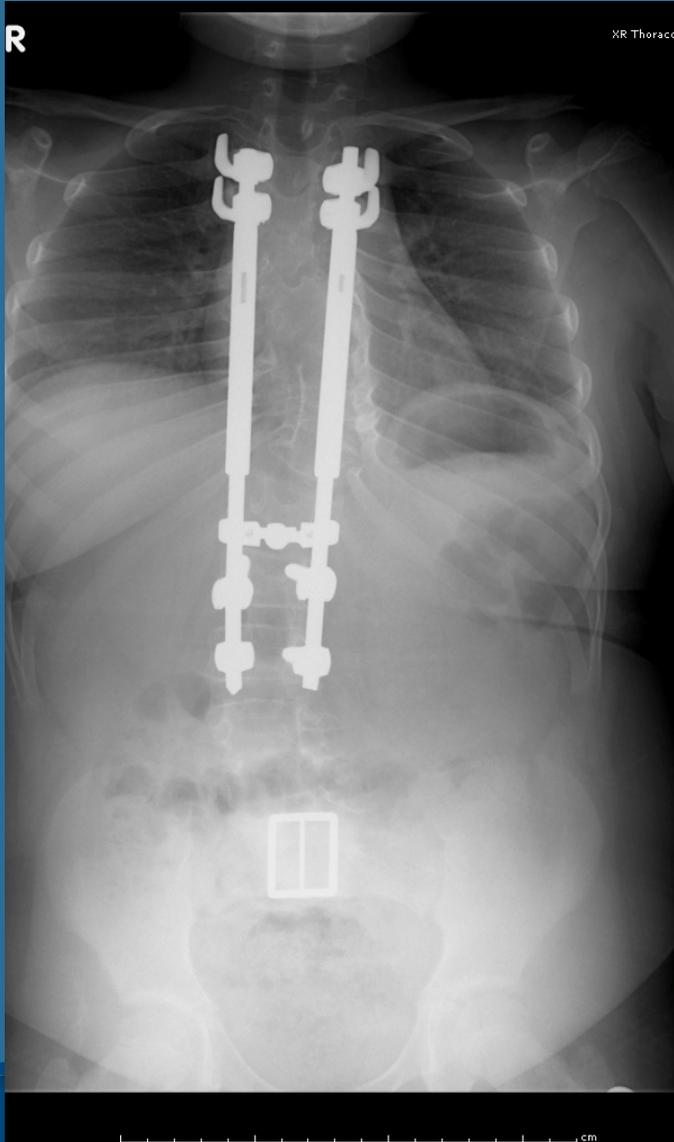
Lee, et al, PJK in Distraction-Based Growing Rods, SRS, 2011

# Advantages of rib anchors



- Avoid proximal fusion
- Less rigid system
  - Minimize autofusion?
  - Less rod breakage
- Lower Profile
- Less PJK?

# Advantages of rib anchors



- Avoid proximal fusion
- Less rigid system
  - Minimize autofusion?
  - Less rod breakage
- Lower Profile
- Less PJK?

Possible Disadvantage  
– Does it hurt pulmonary function?

# Why use “spine hooks” instead of VEPTR

- Already in hospital
  - Staff familiar
  - Minimize inventory
  - I am more familiar with systems I use daily
- No IRB approval needed
- Less expensive
- Easy to adjust sagittal contour and hook placement

## Why use “spine hooks” instead of VEPTR

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- Easy to adjust sagittal contour and hook placement

My opinion  
Clinical Equipose Between  
“spine hooks” and VEPTR

## Part 2: Technique

- Disclosure - Technique is pretty straightforward
- Few Problems

# Midline Incision - Plan for final fusion

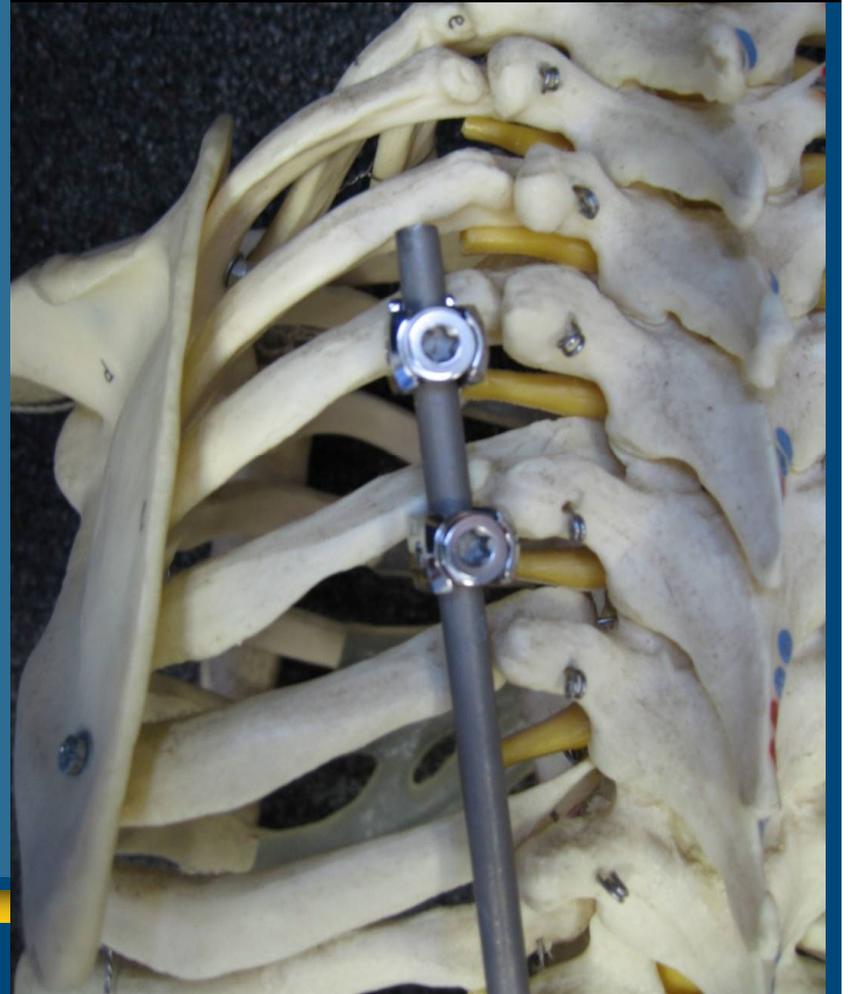


**Single Rod Case  
3 and 5 cm incisions  
no thoracotomy**

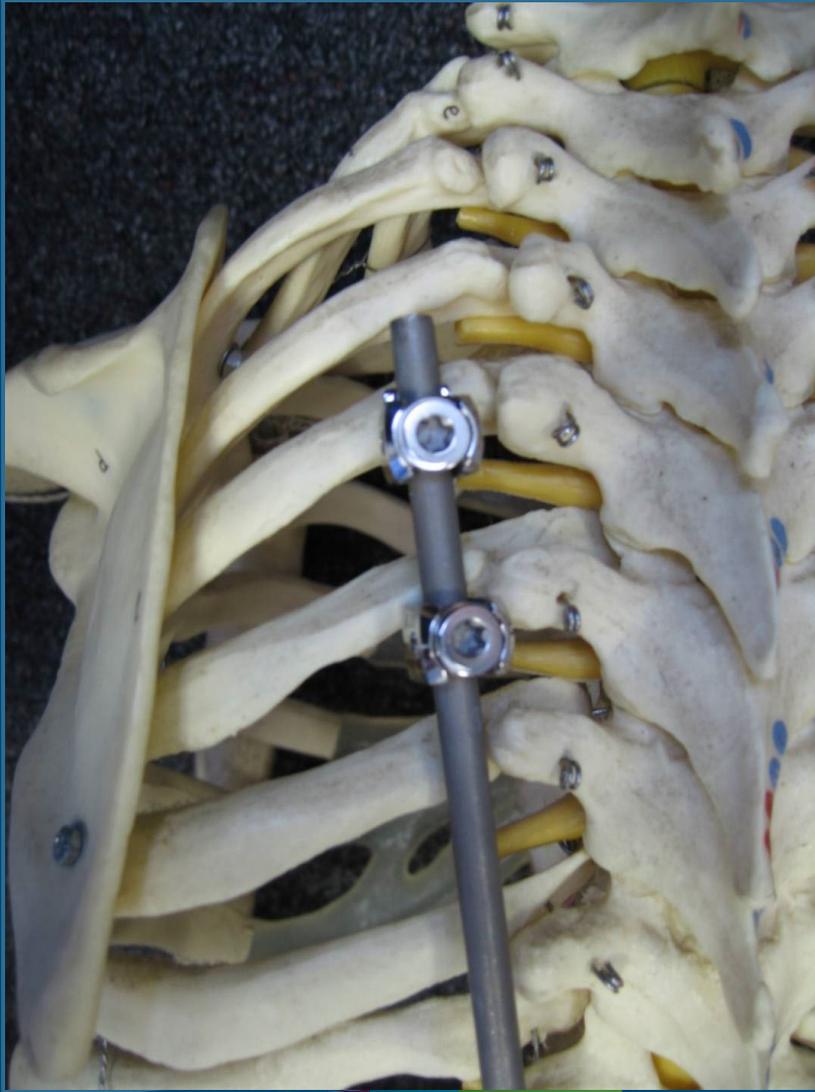
# Midline Incision - Plan for final fusion

- No Dissection of Proximal Spine
- Feel bump of transverse process
- Split muscles just lateral to TP

## Adjacent to TP



# Adjacent to TP

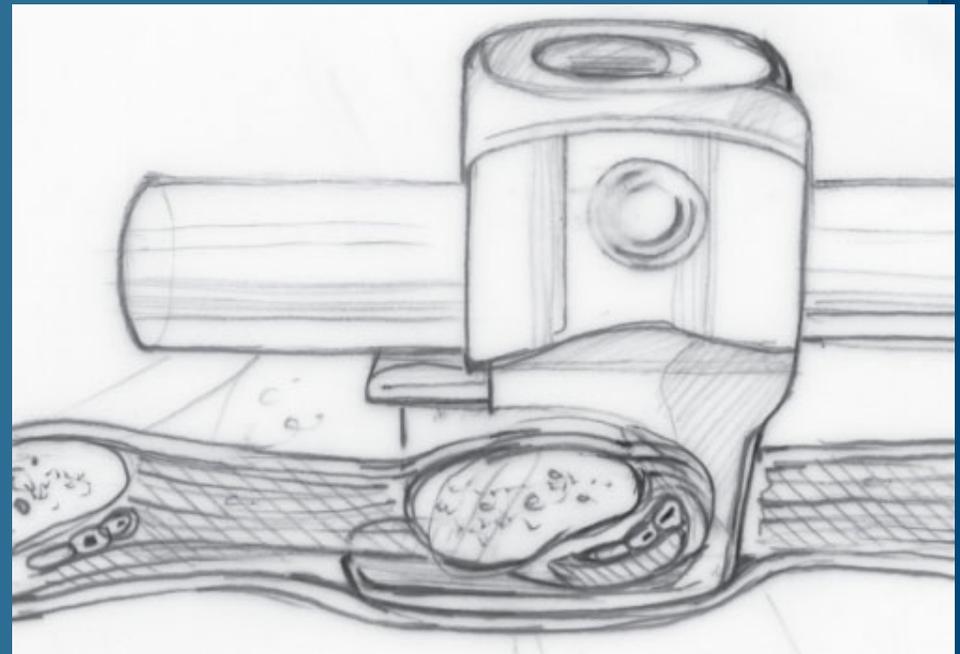


Extra-Periosteal

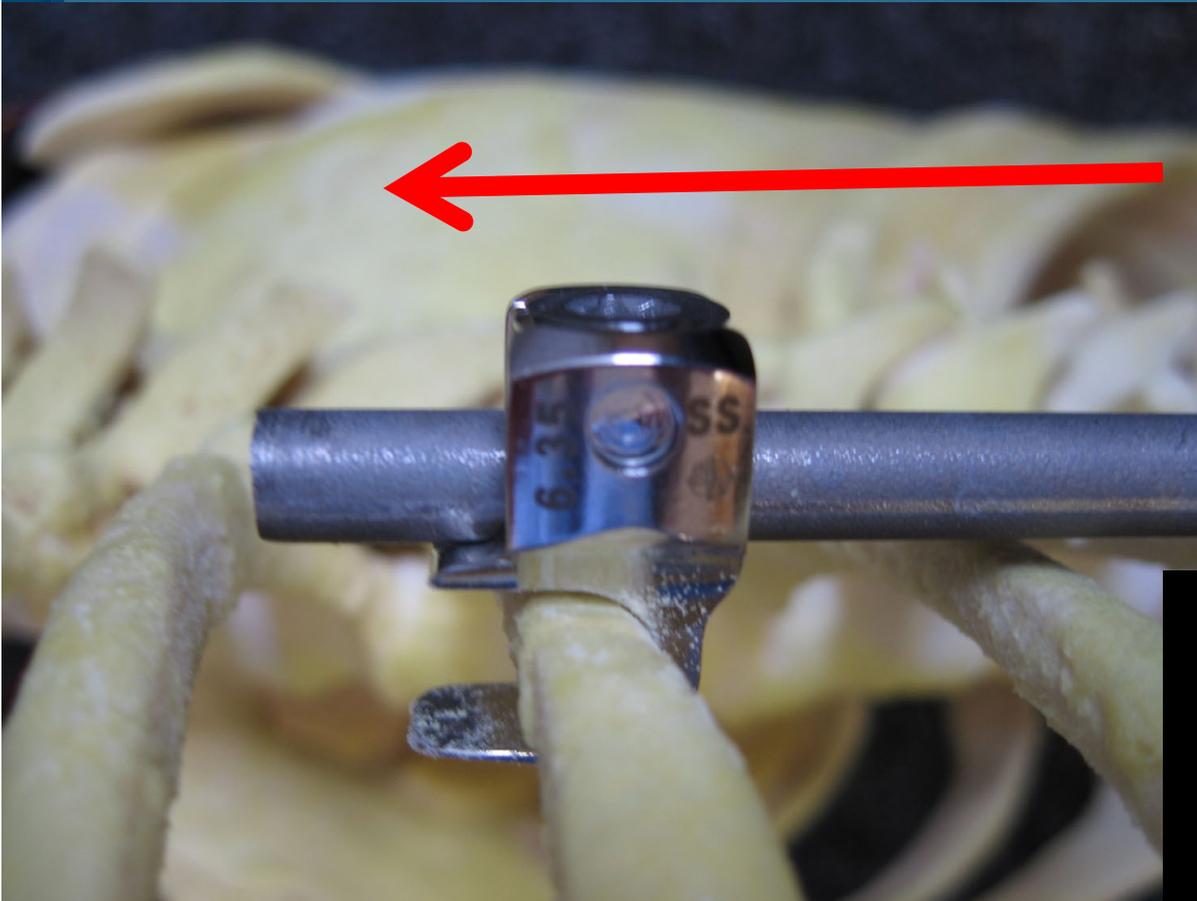
Want ribs to hypertrophy

NOT in chest

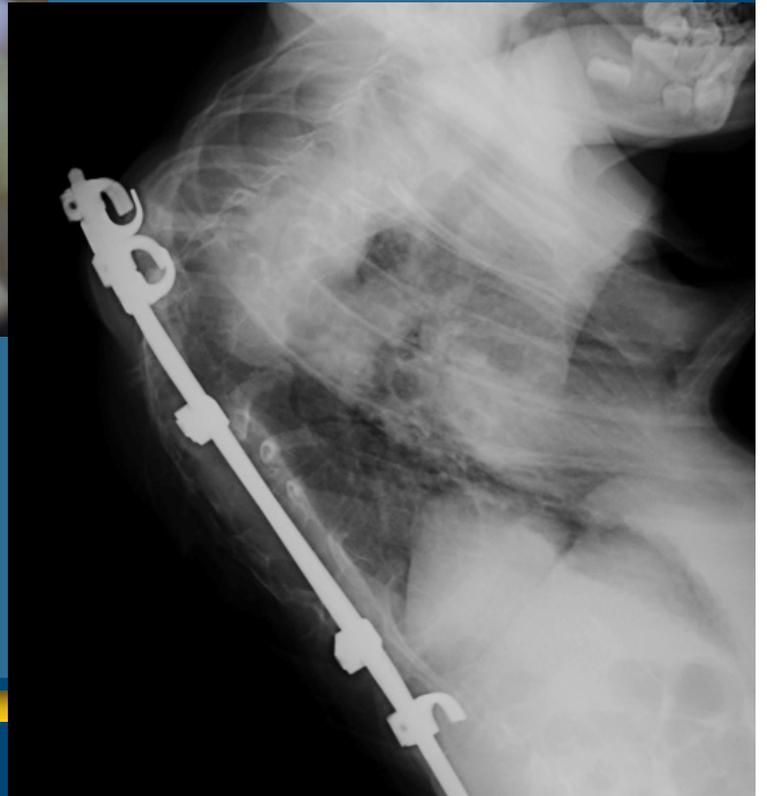
No chest tube



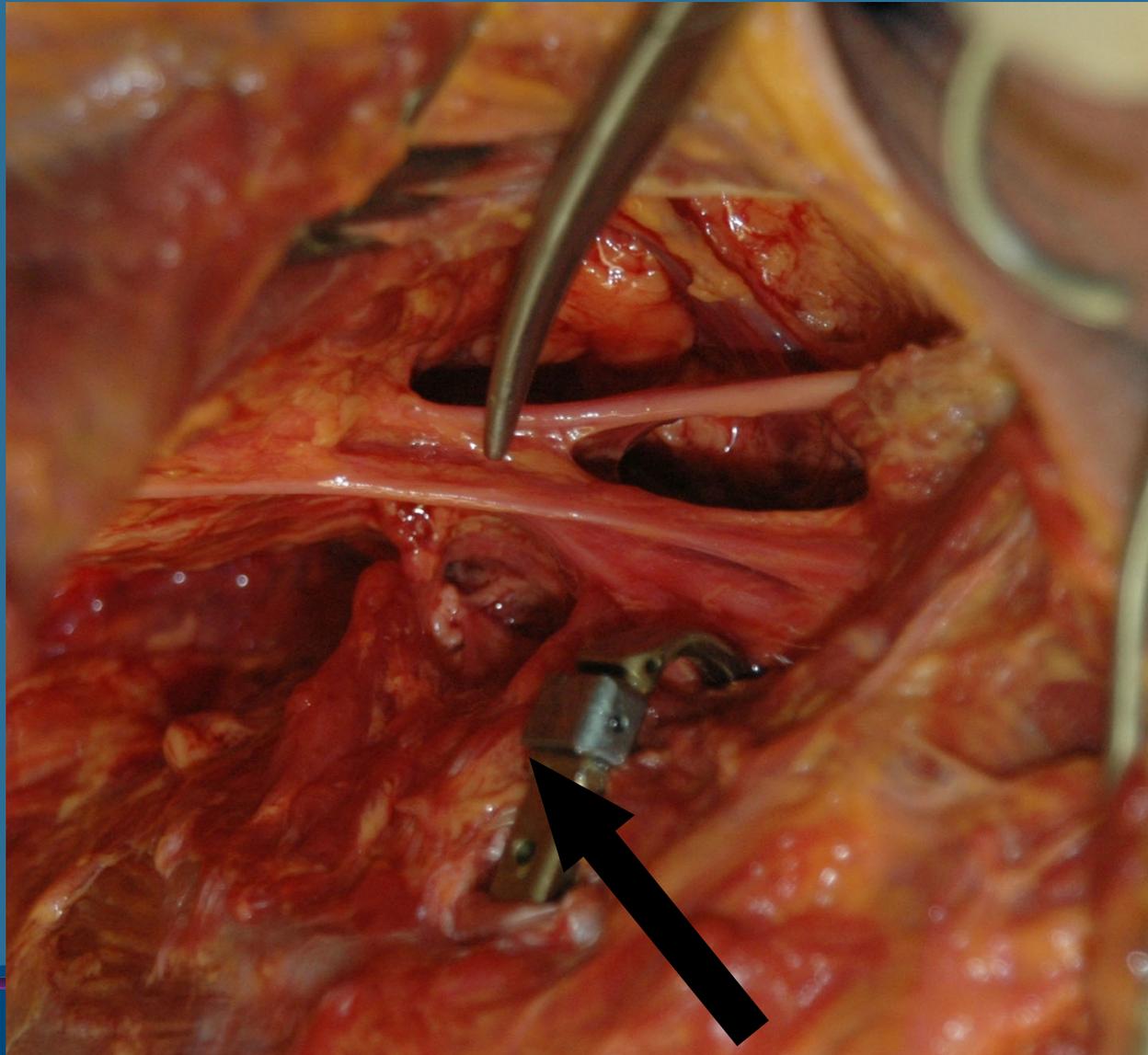
ORTHOPAEDIC CENTER



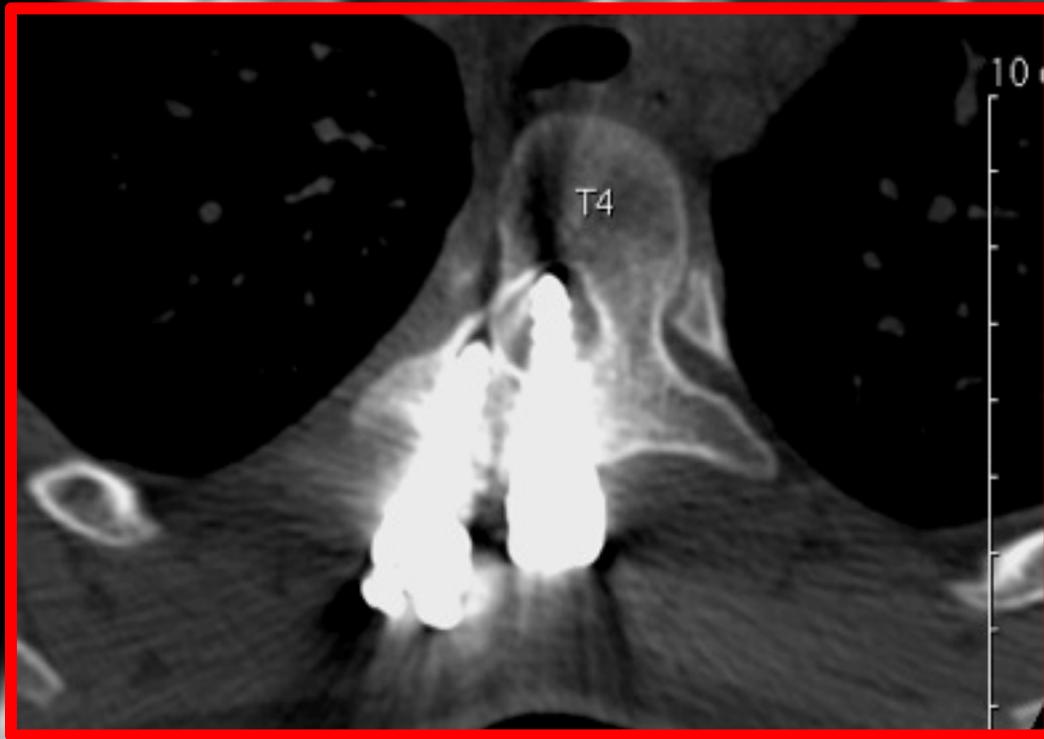
No Advantage to  
"Claw"



# Don't use first rib



# Fails Posterior



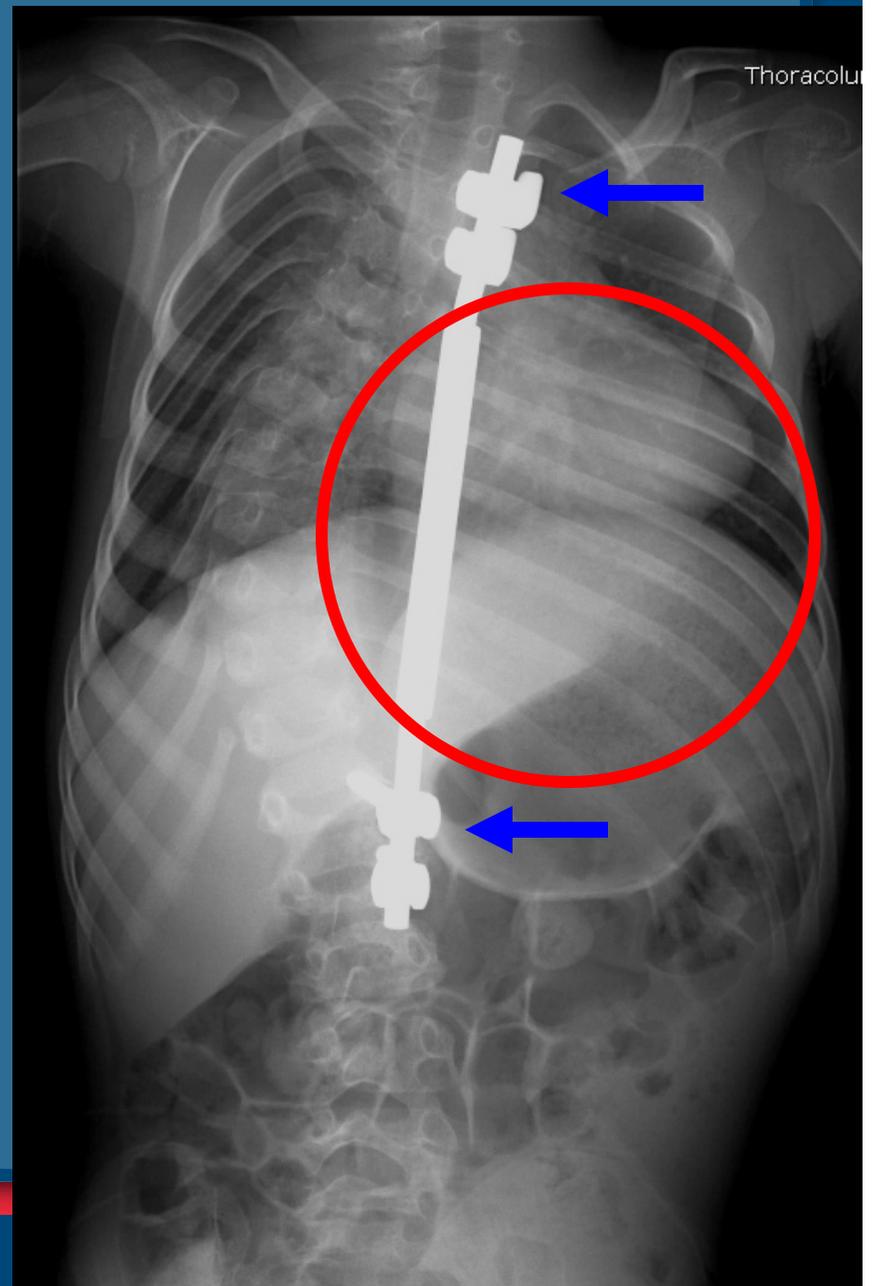
©Behrang Amini, MD/PhD

## Case Example 5yo boy

- Ambulatory
- neuromuscular
- 91° Scoliosis -progressive
- Extremely thin



# Portable Traction

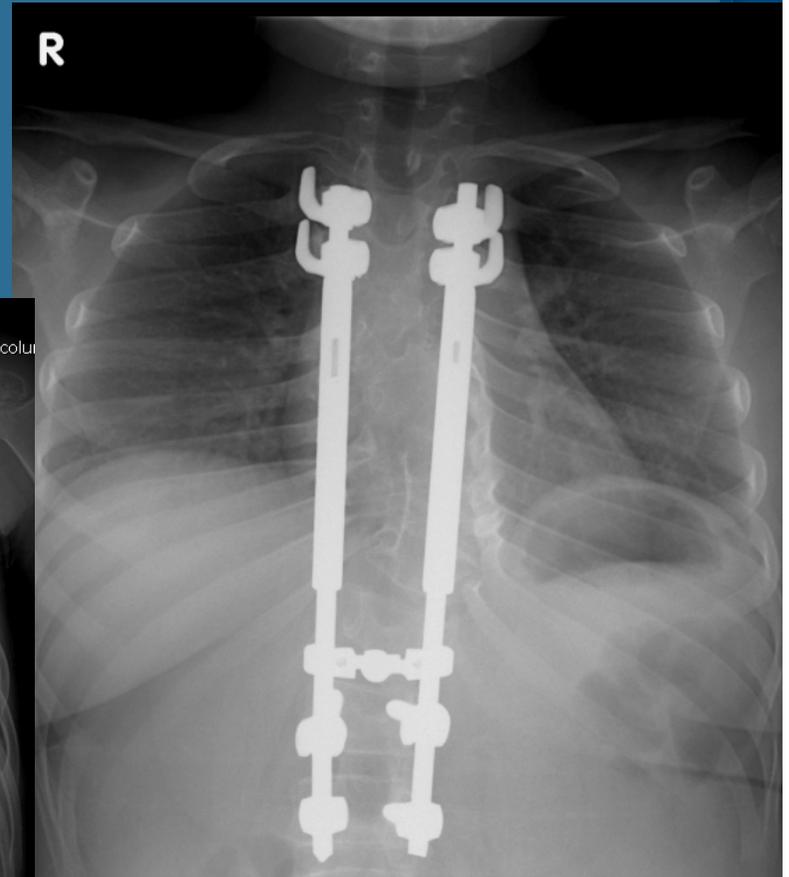
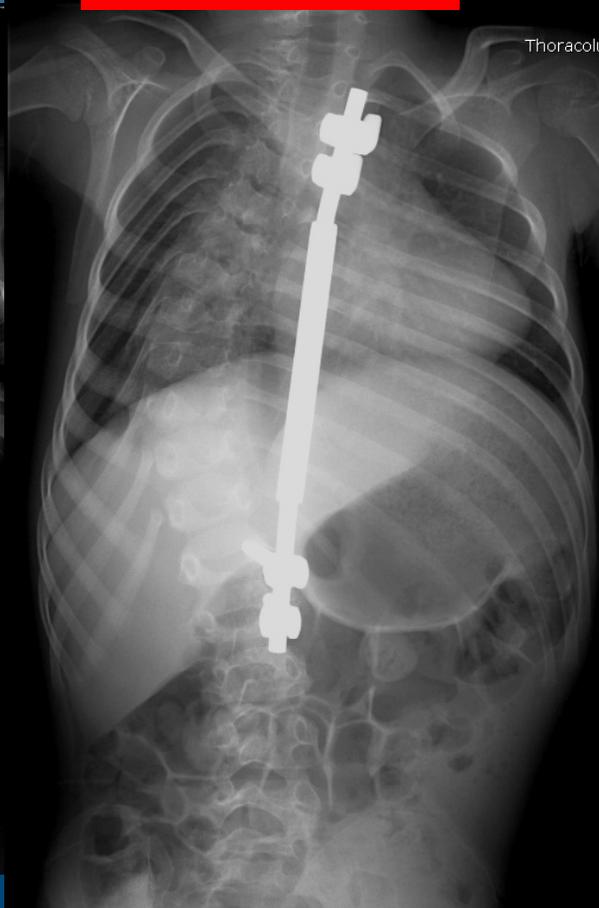


## Current Preference

- Dual-sided constructs
- $\geq 3$  up-going hooks

REALLY thin kids

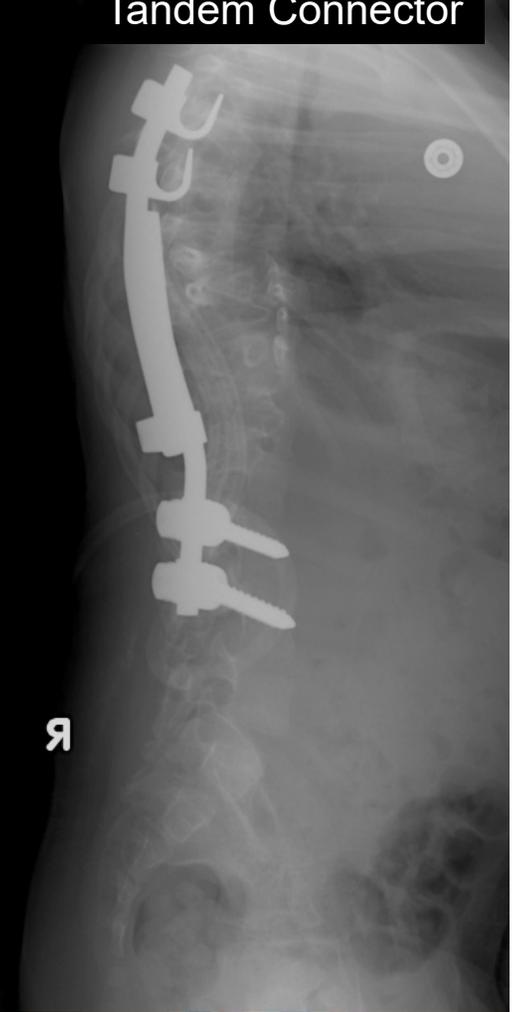
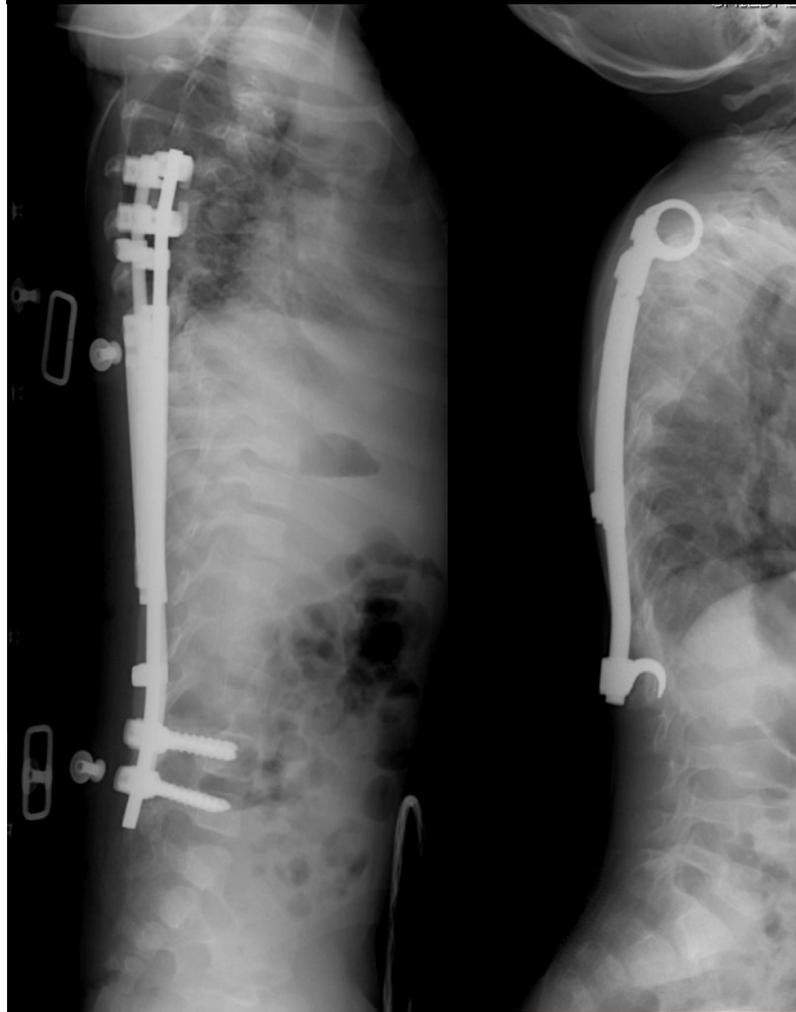
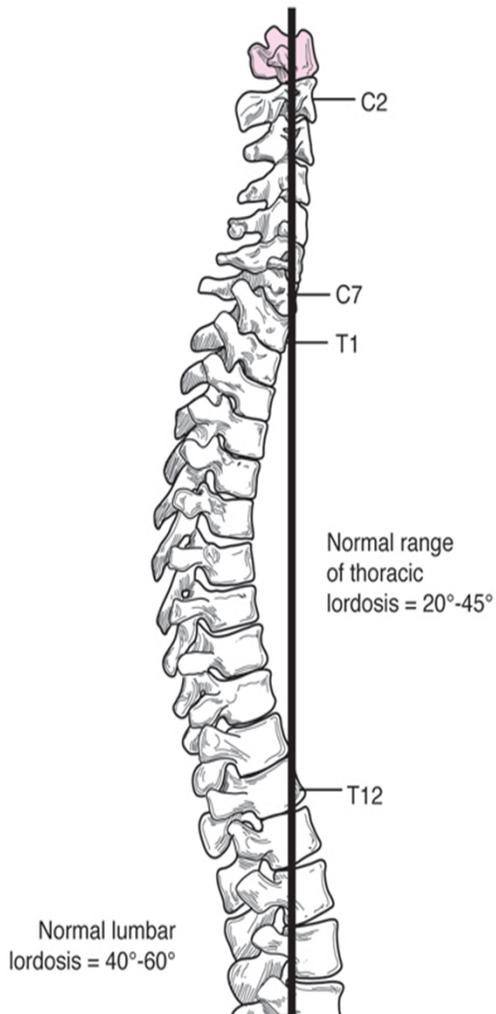
NO Thorcotomy



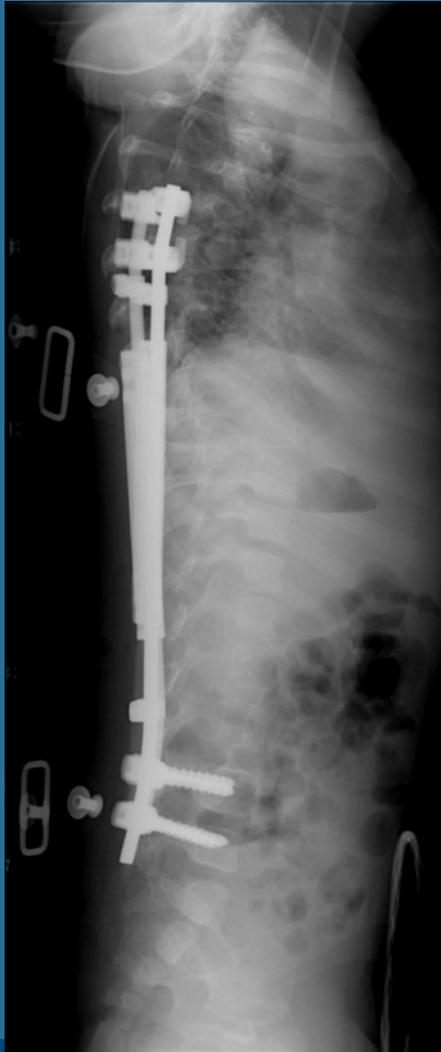
# Sagittal Contouring

Straight Connector    Curved Connector

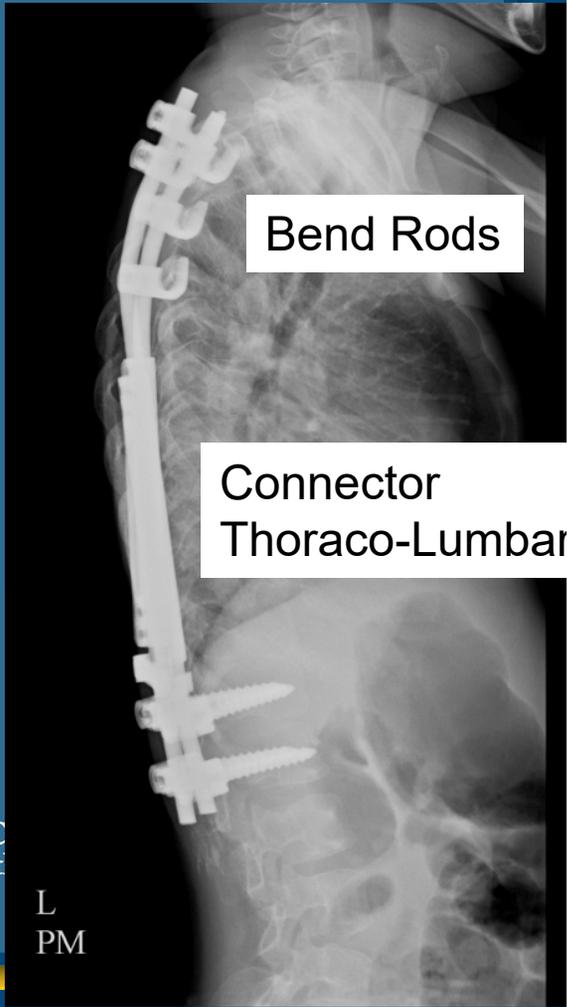
Curved Rod  
Tandem Connector



# Straight Longitudinal Connector



**Too Long (straight)  
Vs.  
Too Short  
(Few lengthenings)**



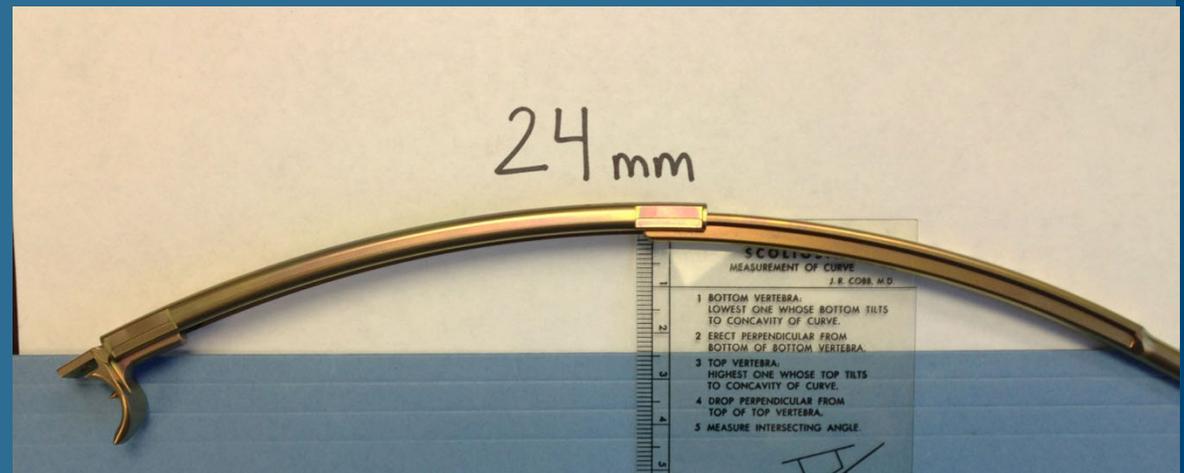
# Lengthening Through Curved Rods

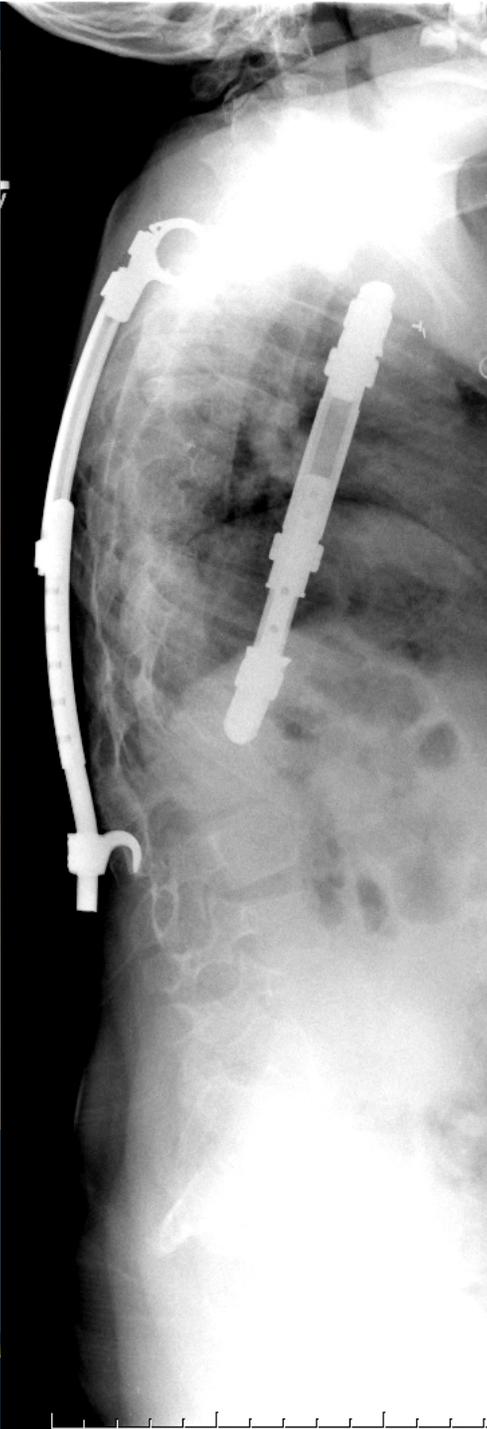
- More Posterior Prominence
- More Kyphosis



# Lengthening Through Curved Rods

- More Posterior Prominence
- More Kyphosis





From  
Charlie Johnston



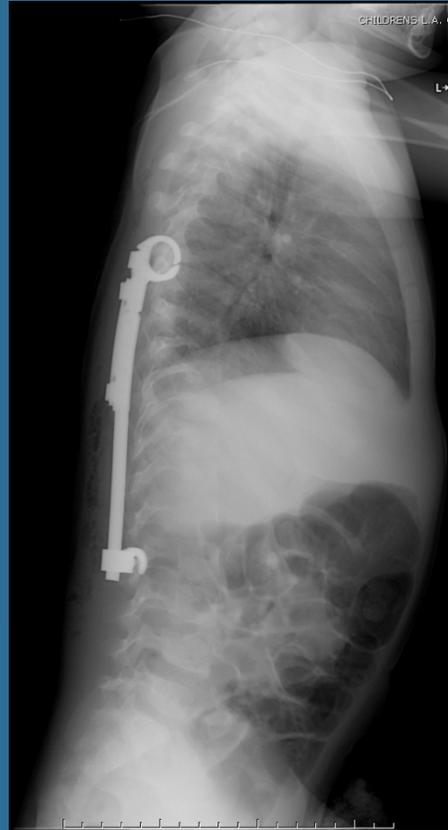
# Lengthening Through Curved Rods

- More Kyphosis
- + Sagittal Balance

4 yo

Same Patient

7 yo



# Rib Anchored

Scoliosis

BAILOUT-Previous infection

Previous

laminectomies/scarring

Multiple rib

fusions/thorocostomy

# Spine Anchored

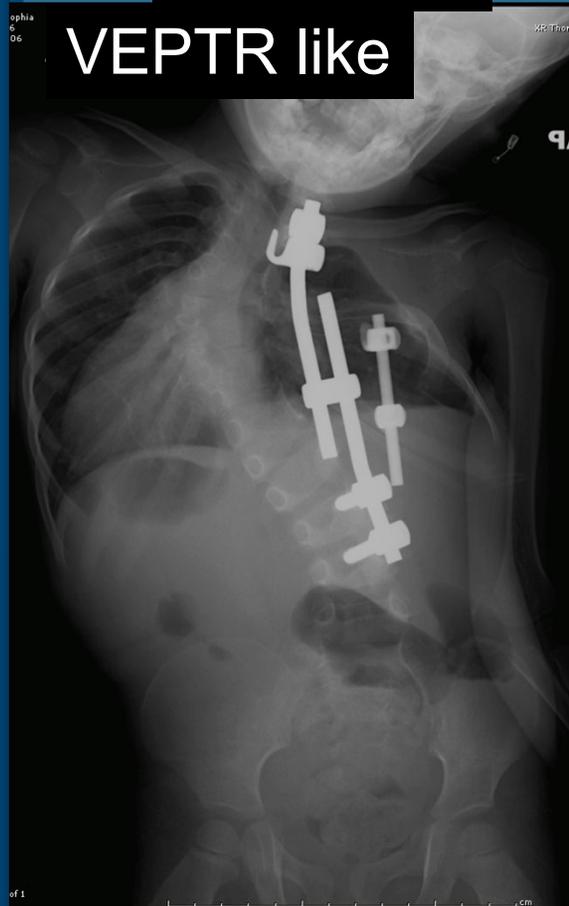
Kyphosis

Thank You

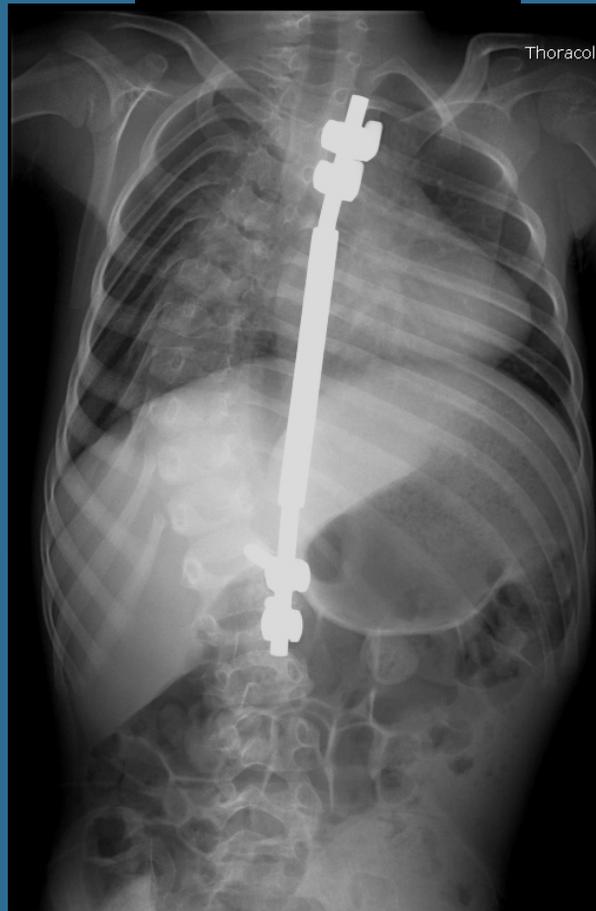


# Many Options

Unilateral  
Dual Rods

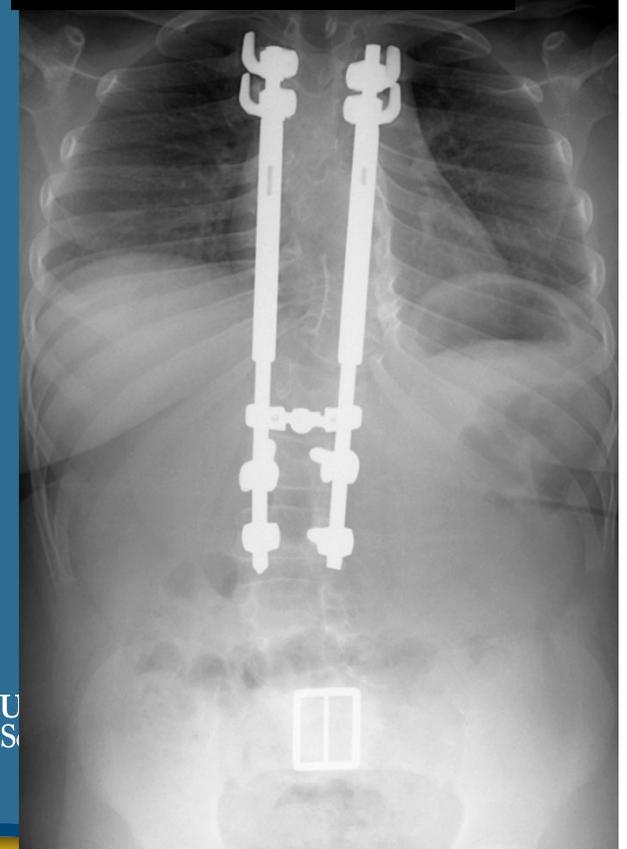


Unilateral  
Single Rods



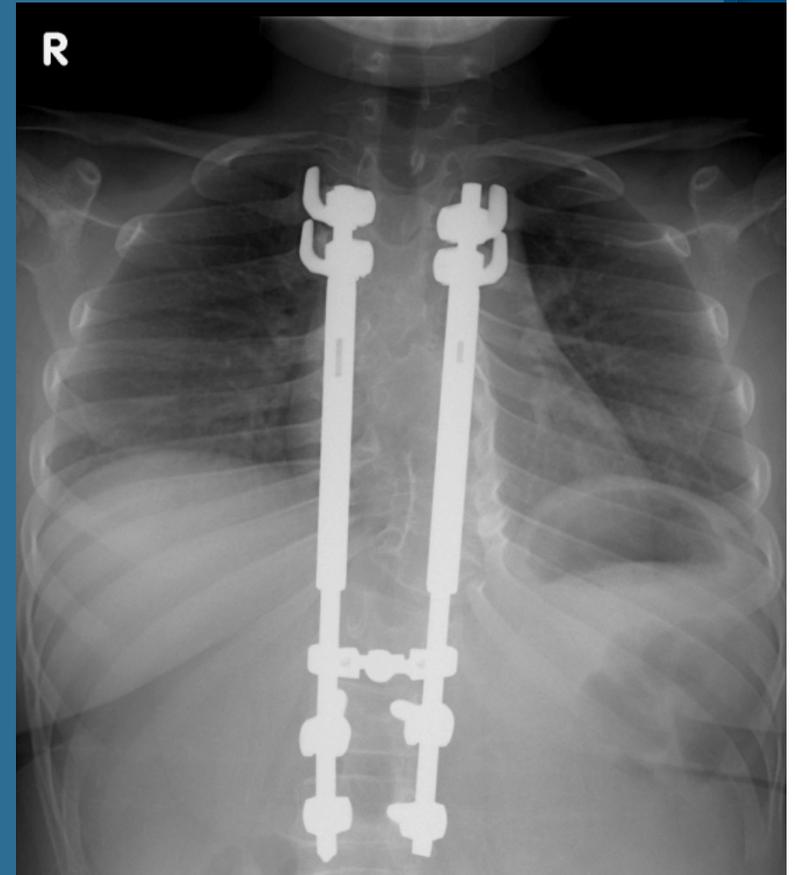
Bilateral  
Dual Rods

Growing rod like



## Current Preference

- Dual-sided constructs
- $\geq 3$  up-going hooks



# T1-S1 Growth

## Normal Growth

0-5 yrs

2.0 cm/yr

5-10 yrs

1.2 cm/yr

Dual Growing Rods,  
2005,2008, 2009

5 + 6 yrs  
39 mo f/u

1.1 -1.8 cm/yr

VEPTR, Congenital  
JBJS, 2003

3 + 3yrs  
50 mo f/u

0.83 cm/yr  
Thoracic only

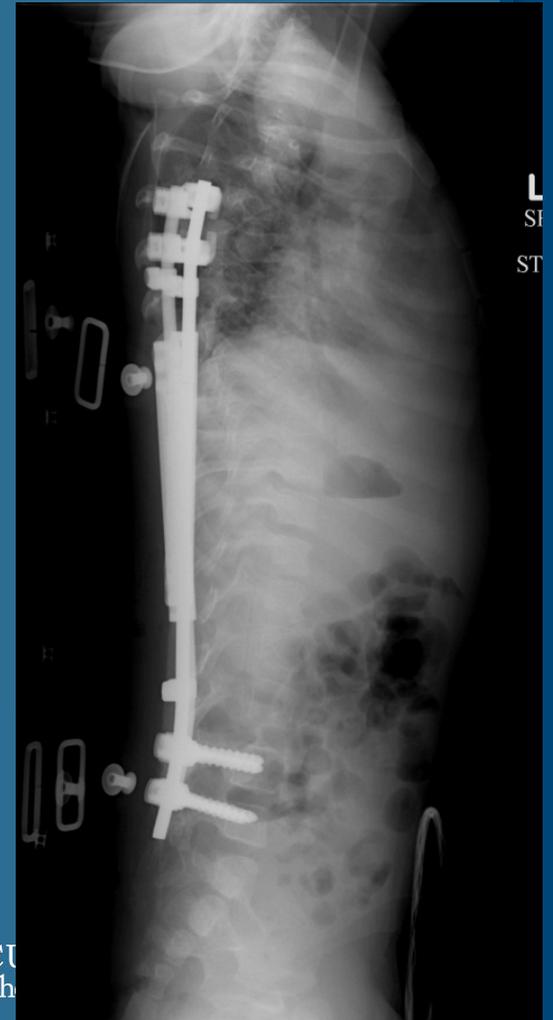
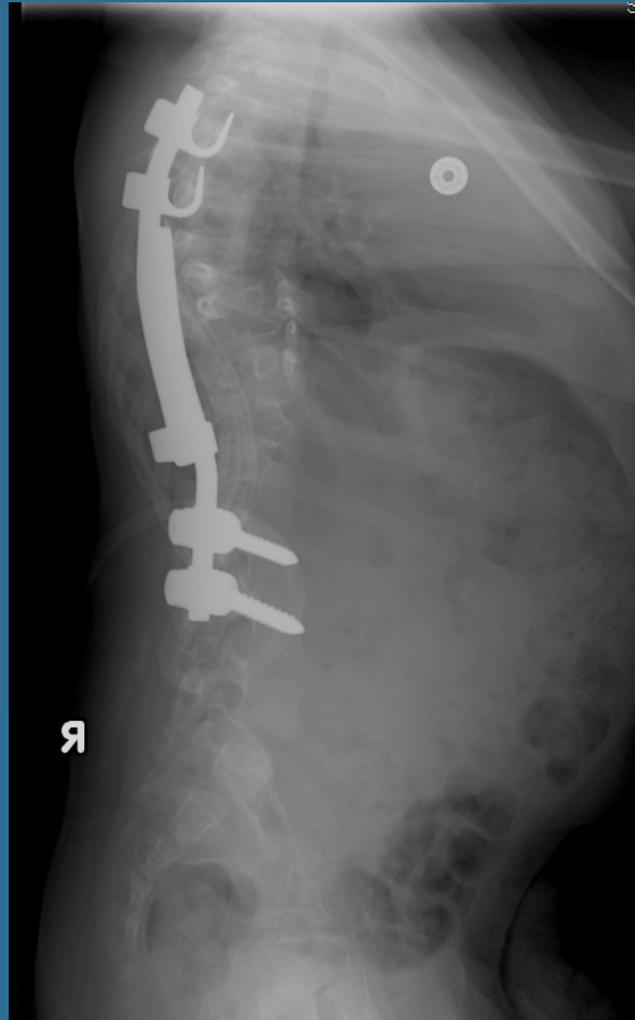
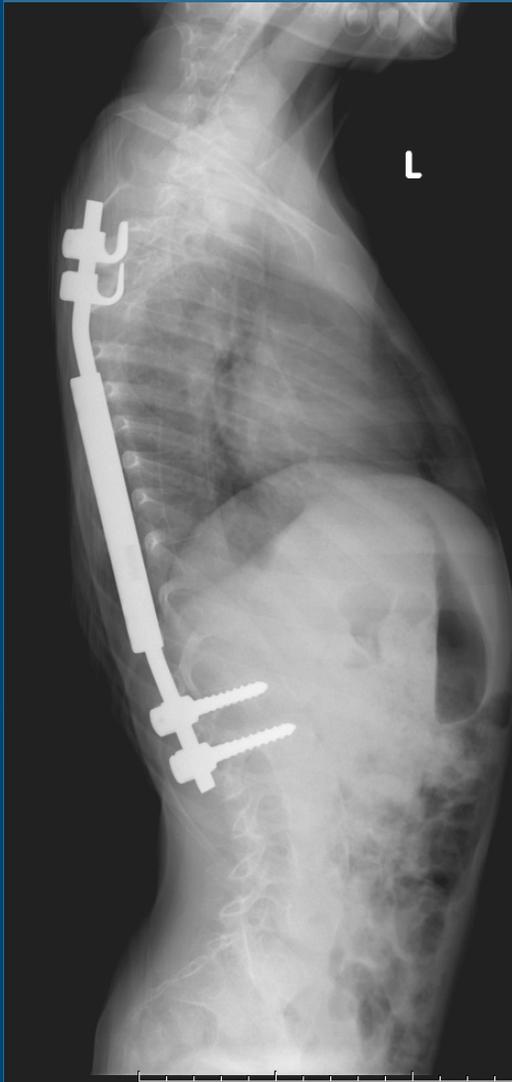
Hybrid Implants

85% congenital

3 + 1 yrs  
37mo f/u

**Unilat -0.65 cm/yr**  
**Bilat-1.2 cm/yr**

# Sagittal Contouring



Thank You



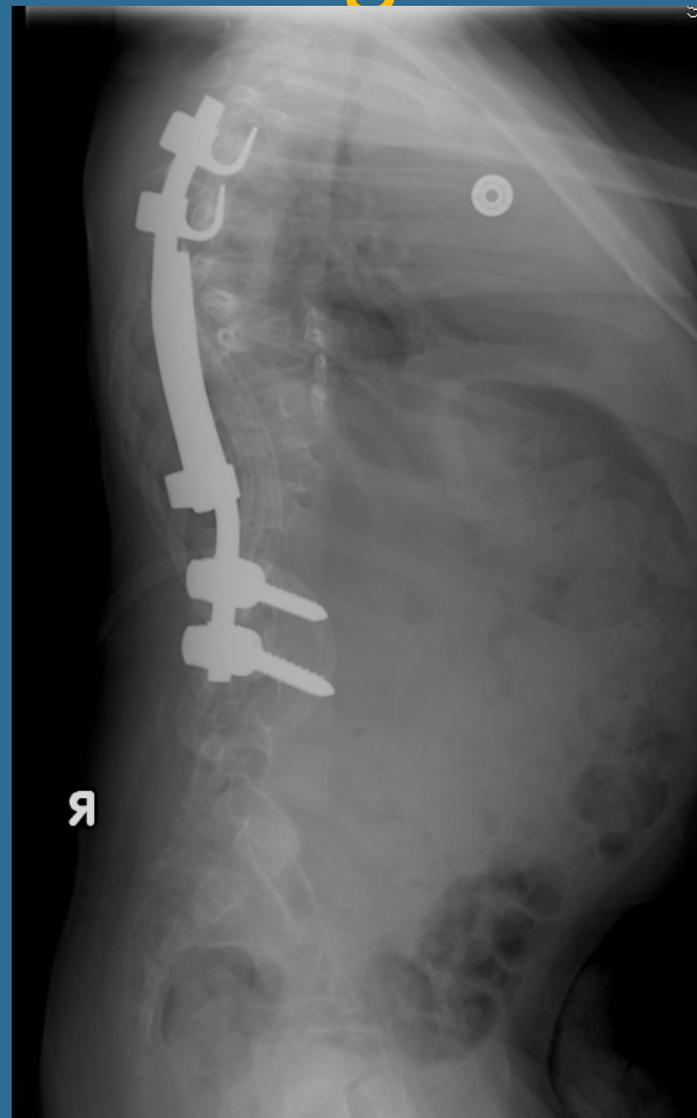
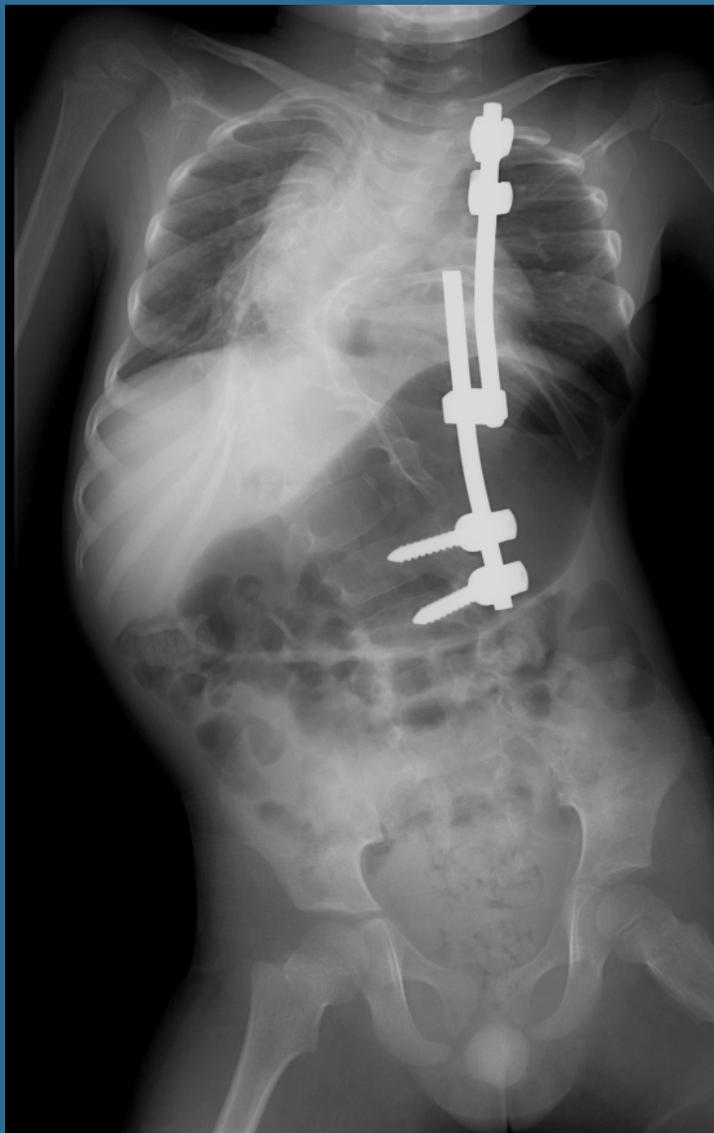
# Video



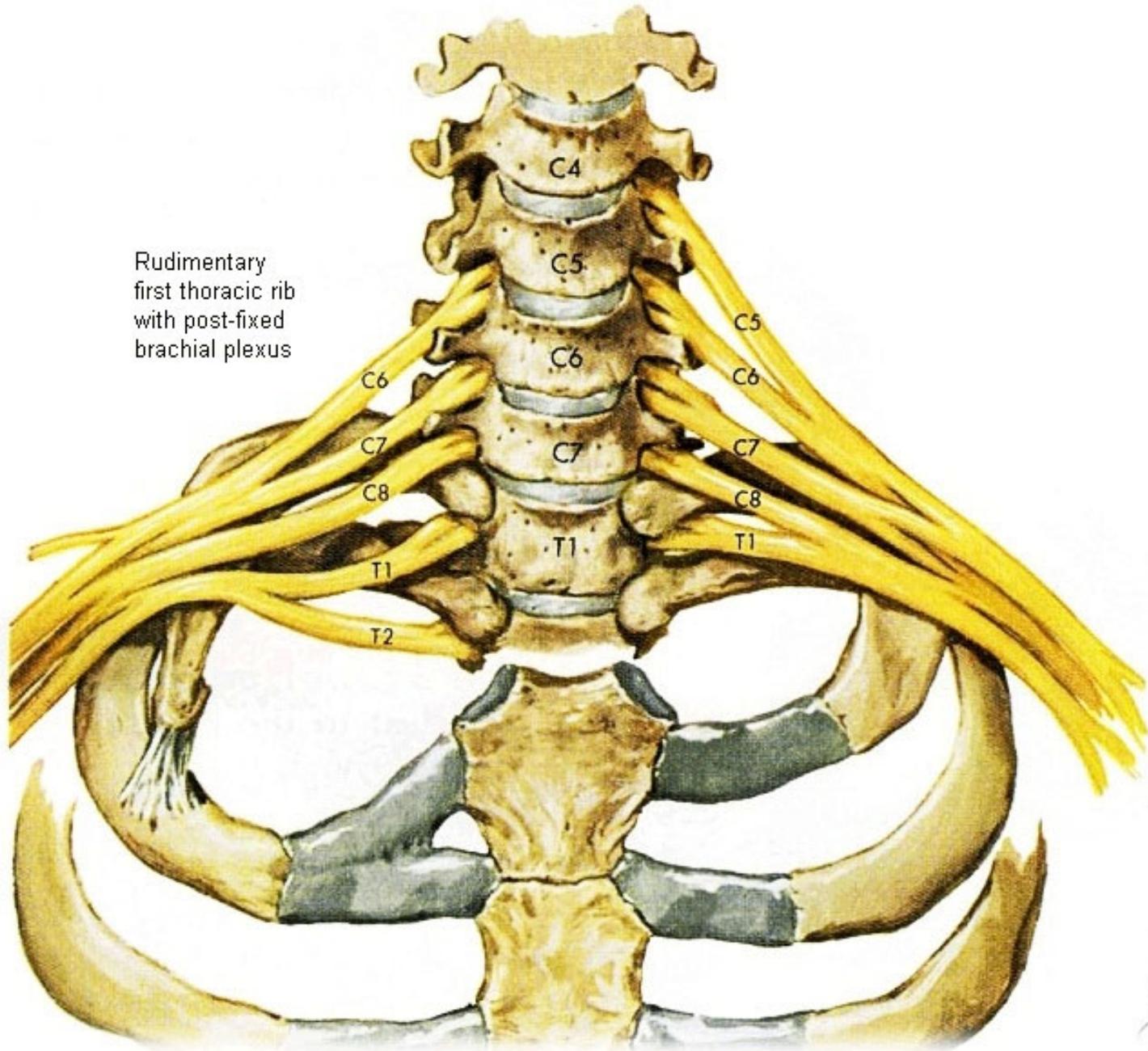
USC University of  
Southern California

Children's  
Hospital  
LOS ANGELES  
CHILDREN'S  
ORTHOPAEDIC CENTER

# Sagittal Contouring



Rudimentary  
first thoracic rib  
with post-fixed  
brachial plexus

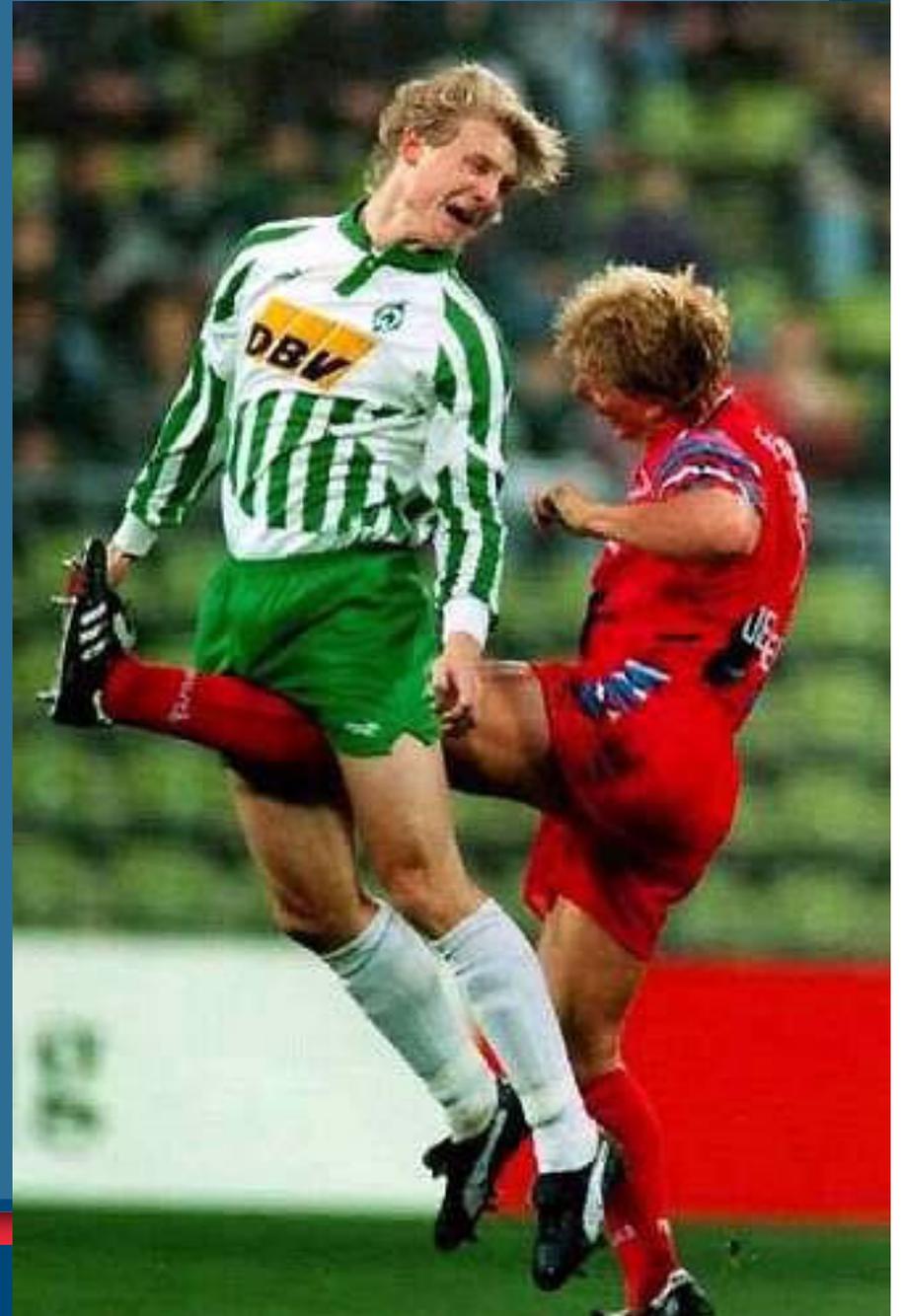


No  
pl

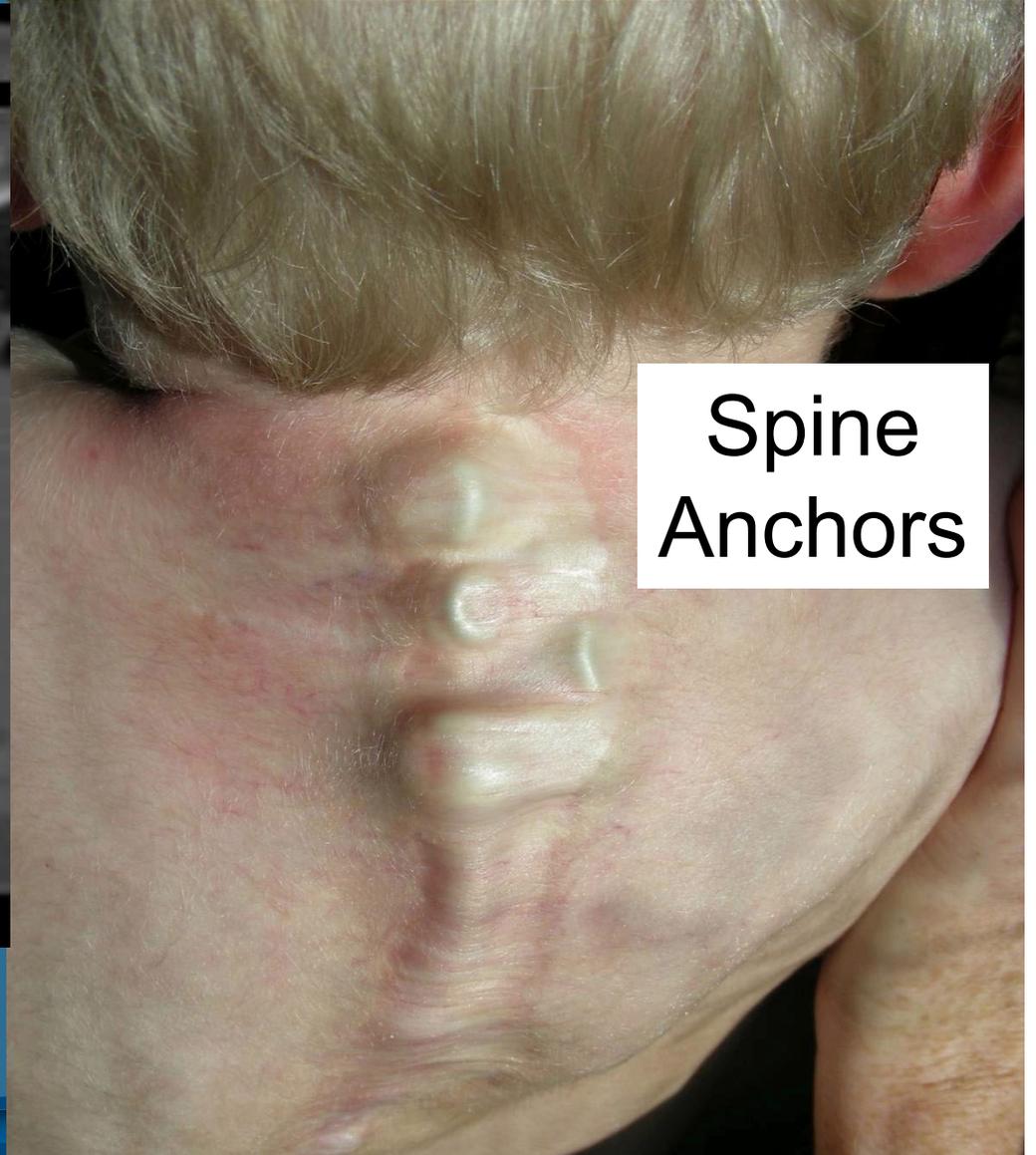
Thank You



Growing Rod  
Surgery is Like ..



# Hooks on Ribs: Lower Profile than Spine



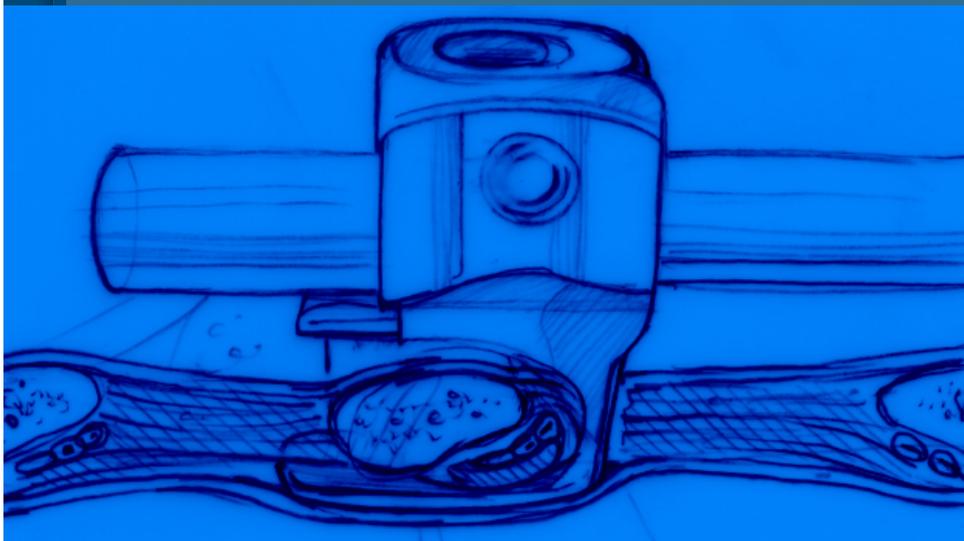
# References

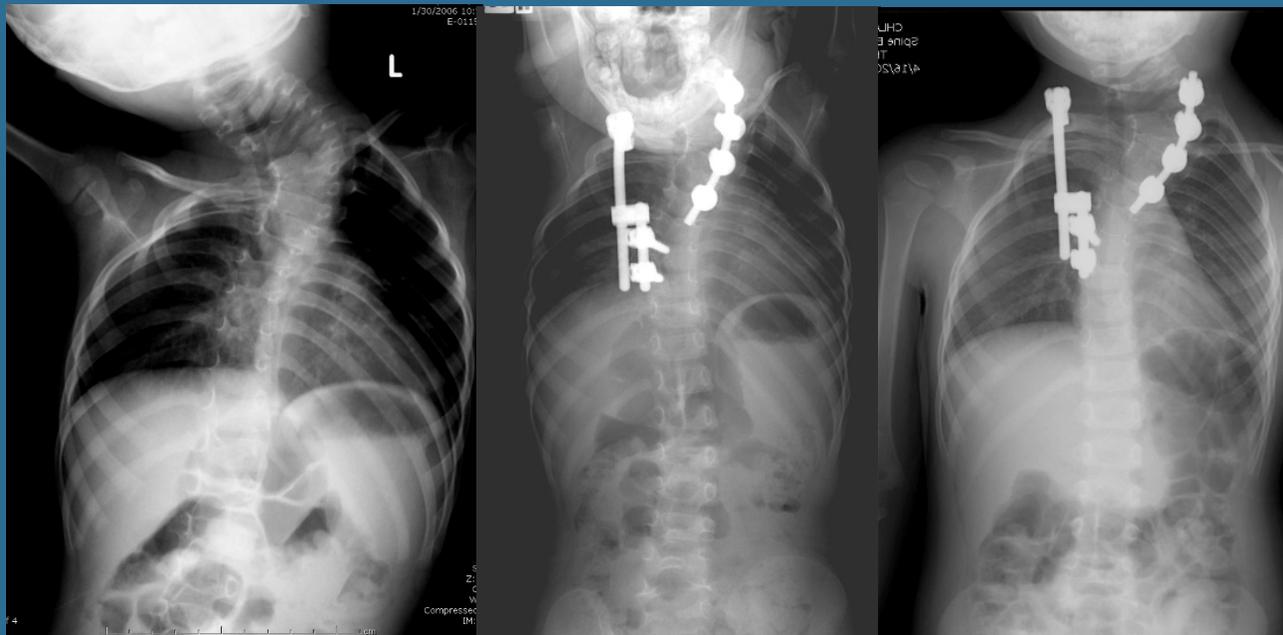
- Campbell, R. M. and A. K. Hell-Vocke (2003). "Growth of the thoracic spine in congenital scoliosis after expansion thoracoplasty." Journal of Bone and Joint Surgery Am **85**: 409-420.
- Campbell, R. M., M. D. Smith, et al. (2003). "The characteristics of thoracic insufficiency syndrome associated with fused ribs and congenital scoliosis." Journal of Bone and Joint Surgery Am **85**: 399-408.
- Campbell, R. M., M. D. Smith, et al. (2004). "The effect of opening wedge thoracostomy on thoracic insufficiency syndrome associated with fused ribs and congenital scoliosis." Journal of Bone and Joint Surgery Am **86**: 1659-1674.
- Davies, G. and L. Reid (1971). "Effect of scoliosis on growth of alveoli and pulmonary arteries on the right ventricle." Archives of Disease in Childhood **46**(249): 623-632.
- Dimeglio, A. (1993). "Growth of the spine before age 5 years." Journal of Pediatric Orthopaedics British **1**: 102-107.
- Emans, J. B., J. F. Caubet, et al. (2005). "The treatment of spine and chest wall deformities with fused ribs by expansion thoracostomy and insertion of vertical expandable prosthetic titanium rib: growth of the thoracic spine and improvement of lung volumes." Spine **13**(17 Suppl.): S58-68.
- Gollogly, S., J. T. Smith, et al. (2004). "Determining lung volume with three dimensional reconstructions of CT scan data: a pilot study to evaluate the effects of expansion thoracoplasty on children with severe spinal deformities." Journal of Pediatric Orthopaedics **24**(323-328).
- Hasler, C.-C. and A. Mehrkens (2010). "Efficacy and safety of VEPTR instrumentation for progressive spine deformities in young children without rib fusions." European Spine Journal **19**: 400-408.
- Karol, L. A., C. Johnston, et al. (2008). "Pulmonary function following early thoracic fusion in non-neuromuscular scoliosis." Journal of Bone and Joint Surgery Am **90**(6): 1272-1281.
- Thompson, G. H., B. A. Akbarnia, et al. (2007). "Growing rod techniques in early onset scoliosis." Orthop **27**(3): 354-361.



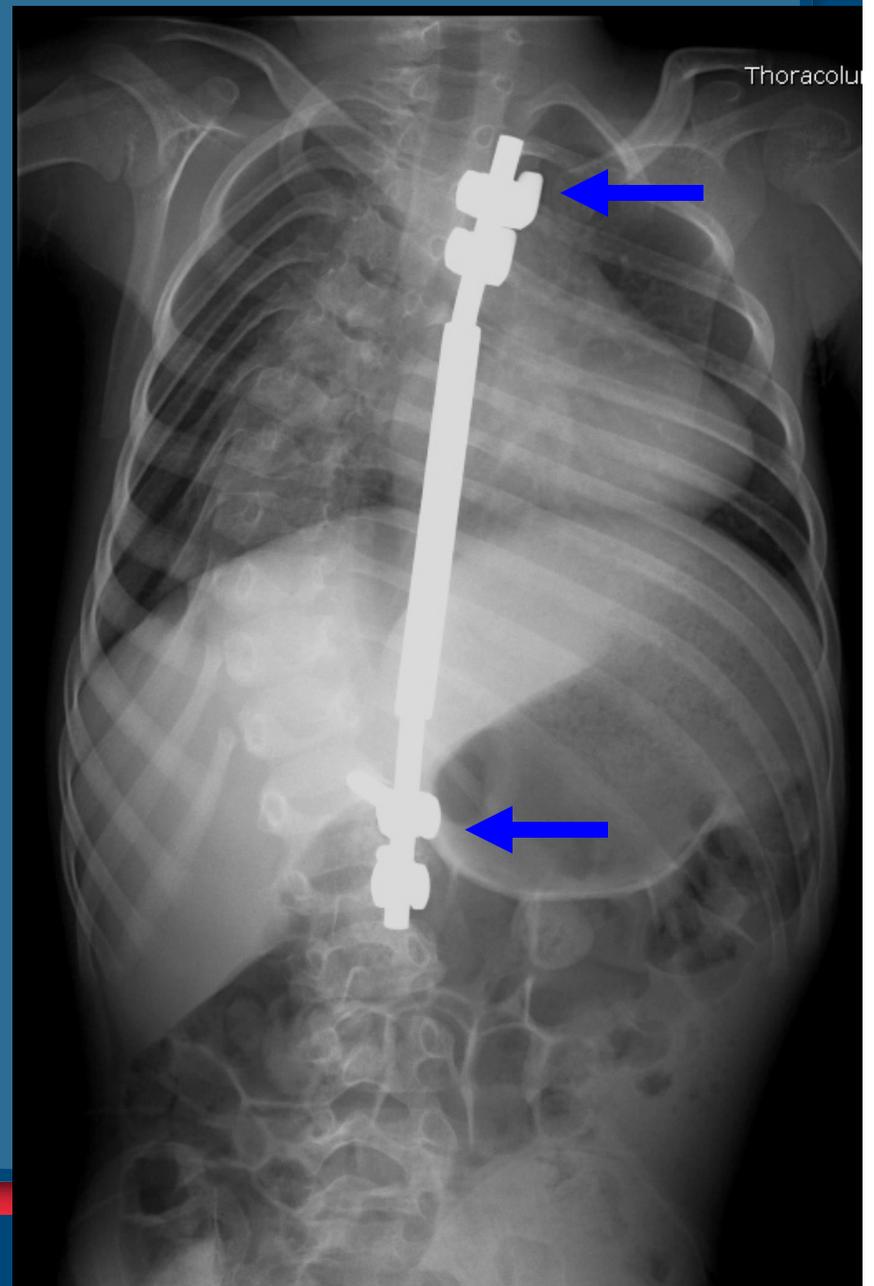
# Purpose

- To report the early results of this technique.

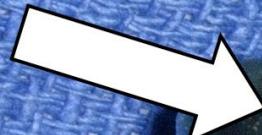




# Portable Traction

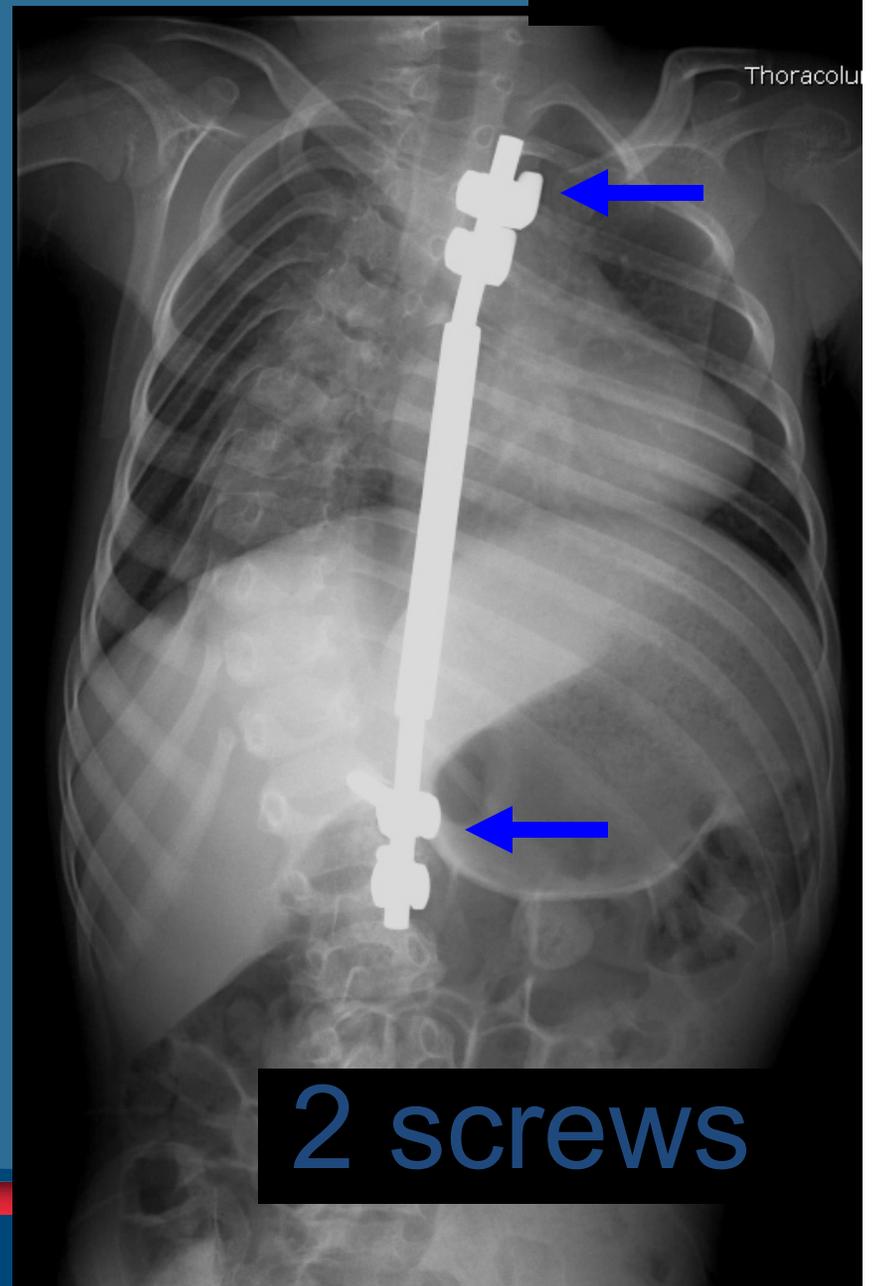


3.5 mm



# No Thoracotomy

2 ribs



# Complications

- Risk factors:
  - Younger age at index surgery ( $p=0.12$ )
  - Larger initial Cobb angle ( $p=0.12$ )

	% rod breakage
Traditional Growing Rods	120% (12 /10)
Hybrid growing rods	0% (0/6)
Veptr	31% (6/19)



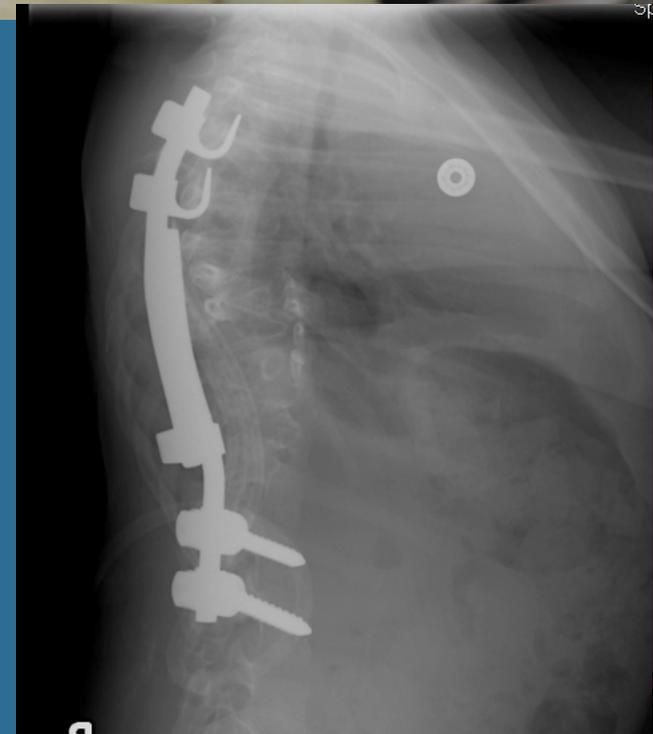


CHILDREN'S  
ORTHOPAEDIC CENTER



USC University of  
Southern California

- FDA Off label
- No IRB approval
- \$ < VEPTR
- Allows precise hook placements - non-constrained
  - Sagittal contouring

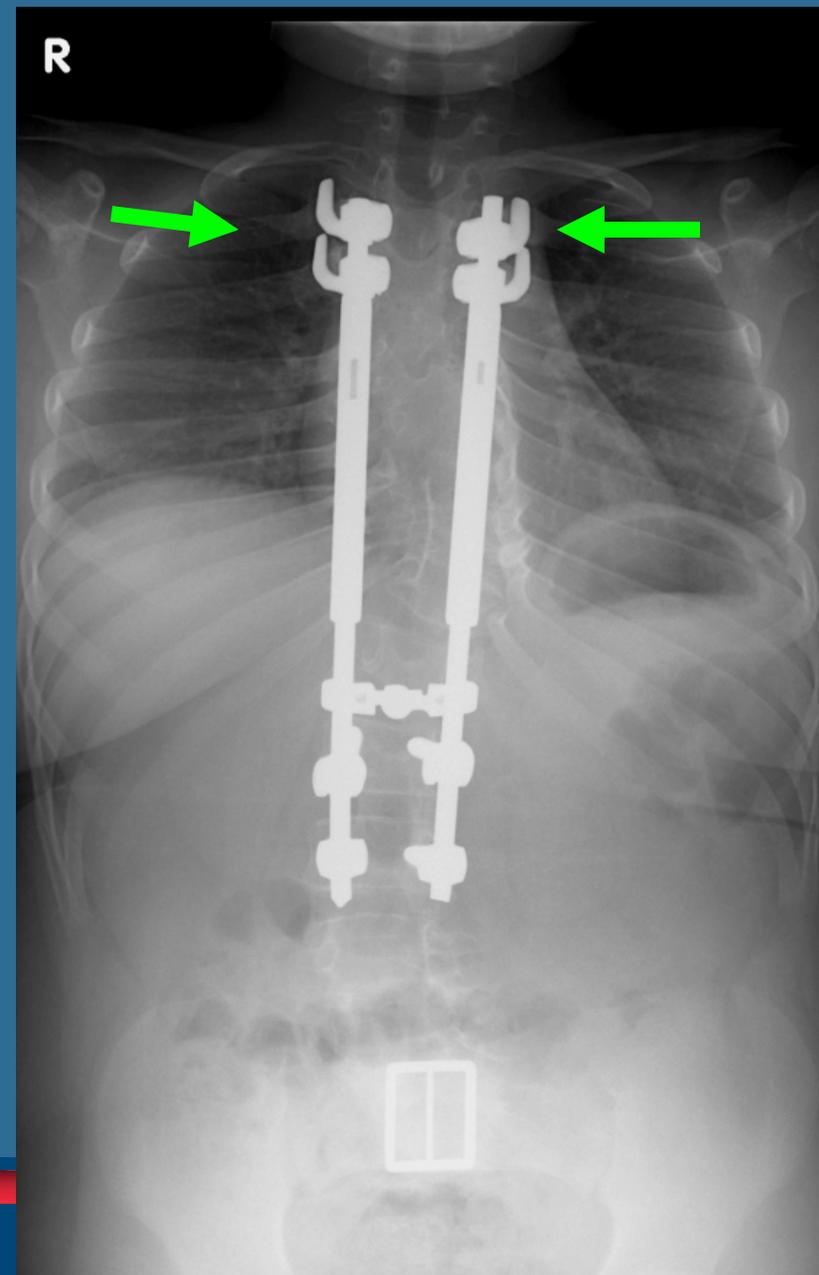
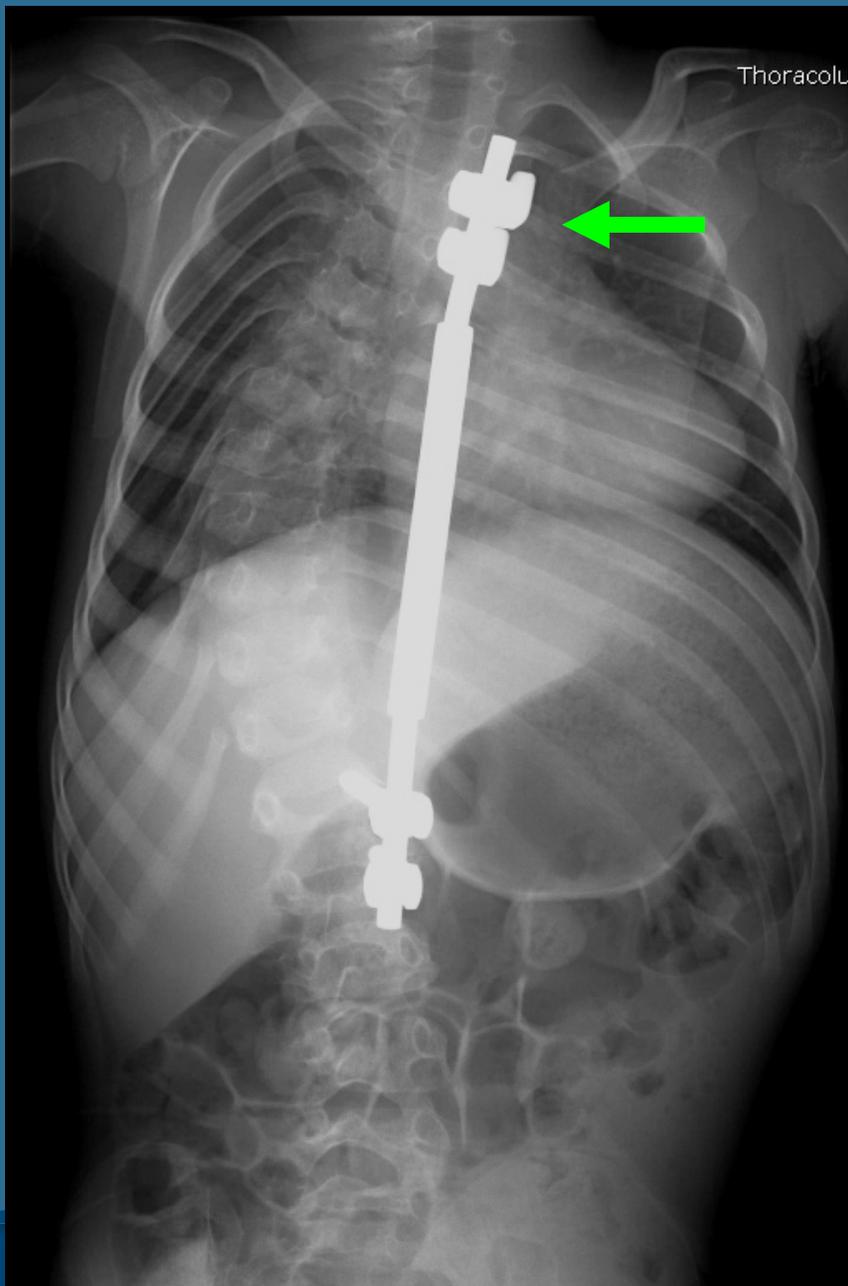


## Conclusions

- Complications in Hybrids is less common than other distraction based growth implants
  - Low profile
  - Multiple non-constrained load sharing anchors
  - Bend Sagittal profile to meet patients needs
  - Uses standard spine implants (no IRB approval needed)

**Avoids intentional fusion of upper thoracic spine**

# Rib Anchored Distraction Based Implants

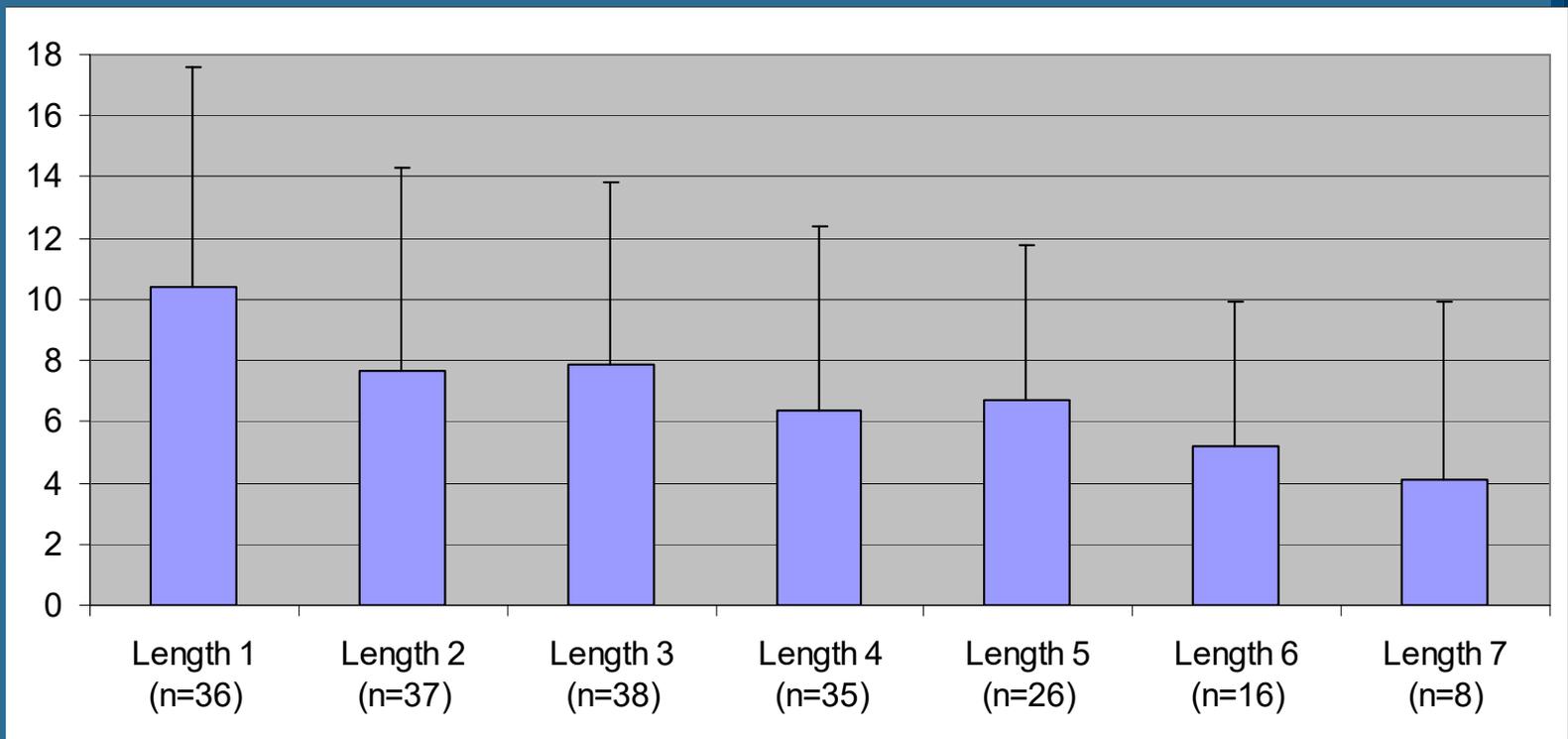


# Growing Rods

## Law of Diminishing Returns

### T1-S1Gain Vs. # of Lengthenings

Gain  
(mm)



# Lengthening

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