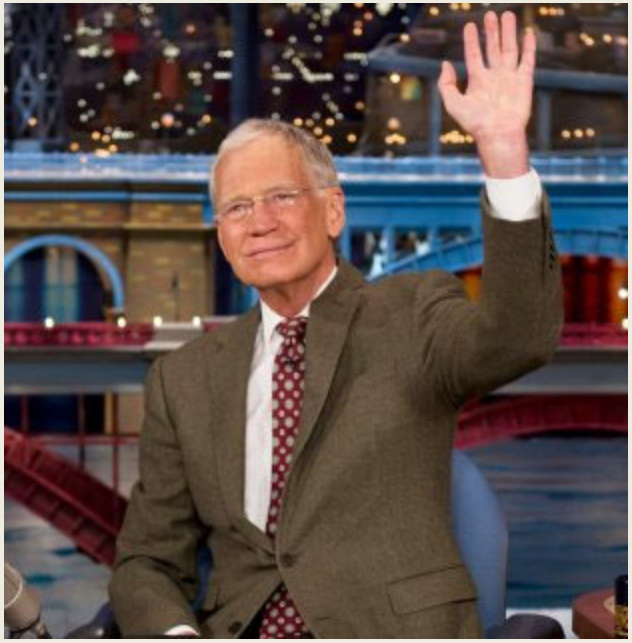
Top 3 Articles That Changed My Approach to EOS

Top 10 List = too long



Kyphosis

Kyphosis

Pulmonary Outcome & T1-12 Length

Kyphosis and Early-onset Spine Deformity (EOSD)

A Problem Seeking a Solution ??

C.E. Johnston MD

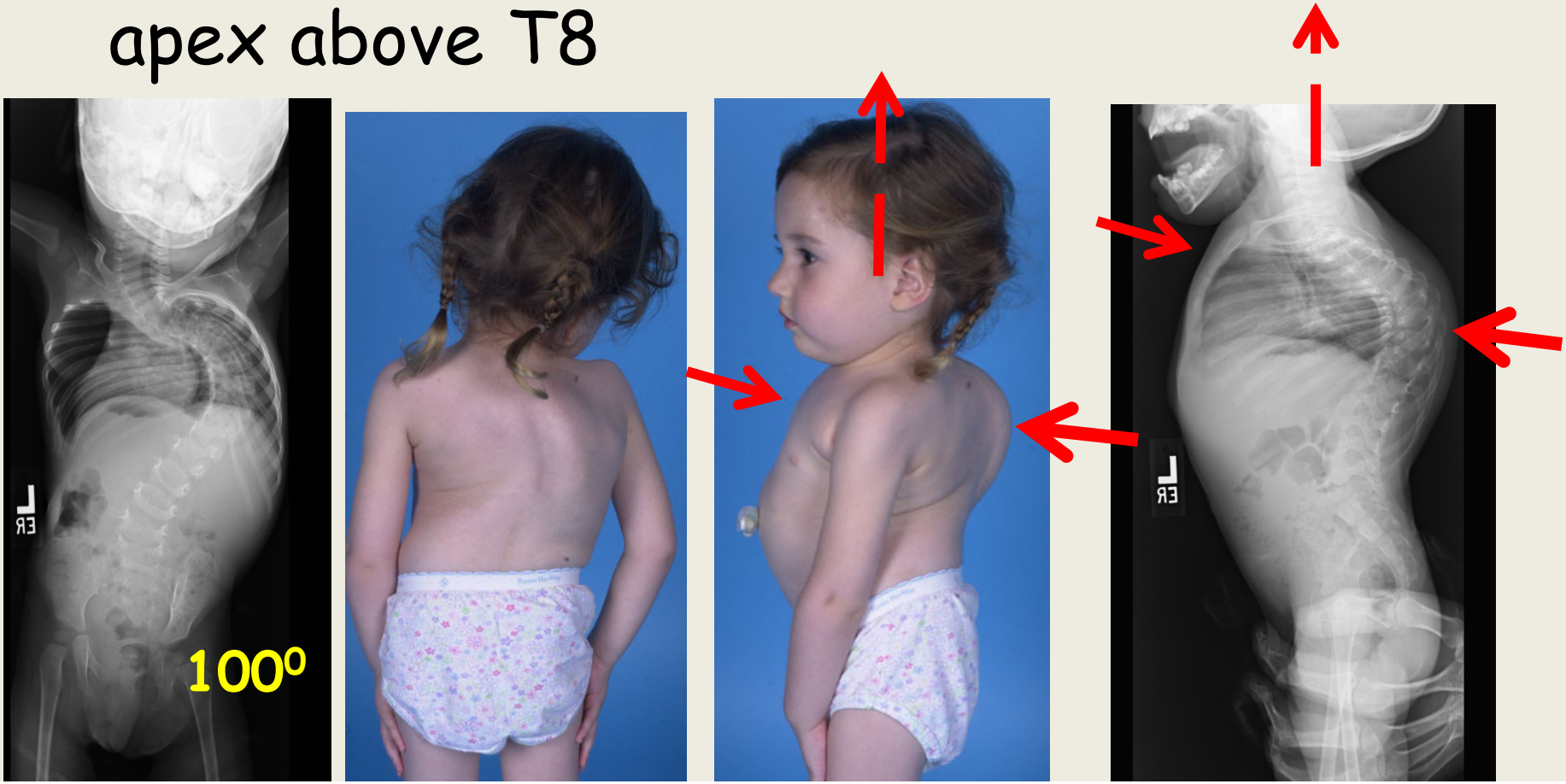
ICEOS Warsaw 2014

Disclosures : Medtronic (research support, financial support/other)
Elsevier (financial)

TEXAS SCOTTISH RITE HOSPITAL FOR CHILDREN

"Hyperkyphosis" – Effect on Treatment

- Complicates growth-friendly management (casts, brace, surgical) if apex above T8



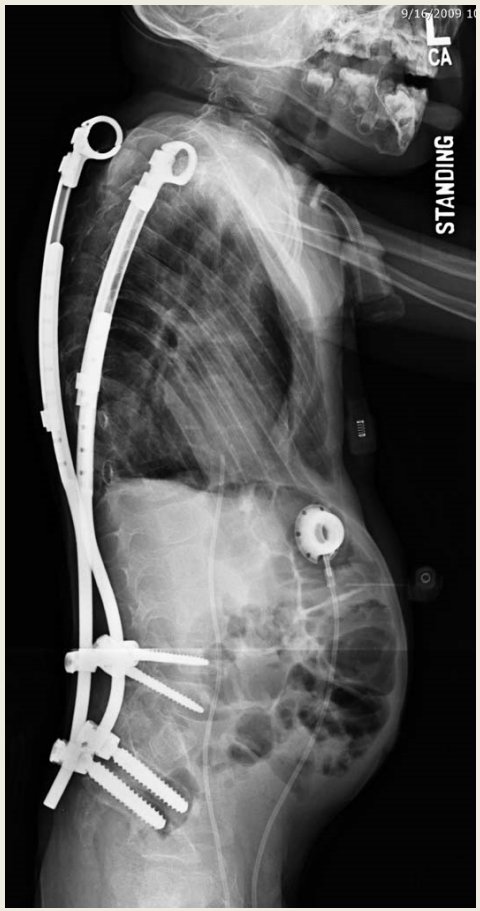
Spine

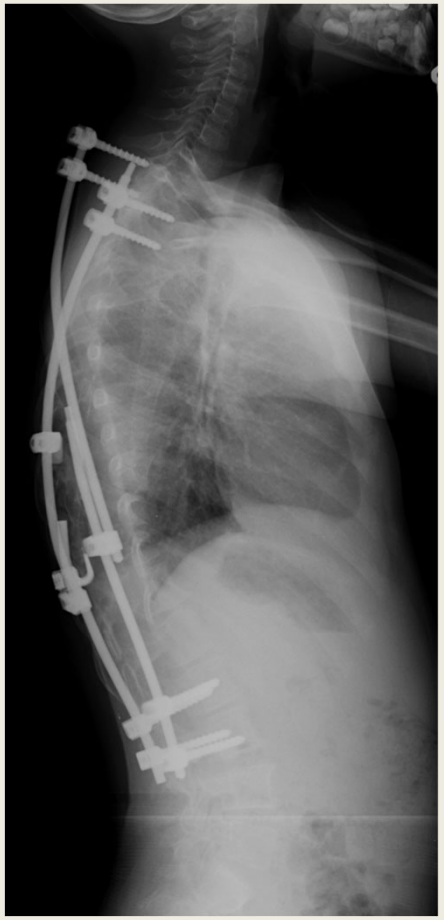
SPINE Volume 37, Number 15, pp 1303–1309

DEFORMITY

How Does Thoracic Kyphosis Affect Patient Outcomes in Growing Rod Surgery?

Samuel R. Schroerlucke, MD,* Behrooz A. Akbarnia, MD,*† Jeff B. Pawelek, BS,* Pooria Salari, MD,* Gregory M. Mundis, Jr., MD,* Muharrem Yazici, MD,‡ John B. Emans, MD,§ Paul D. Sponseller, MD‖ and Growing Spine Study Group*





Non-flexible Kyphosis - Major Cause of Proximal Anchor Failure

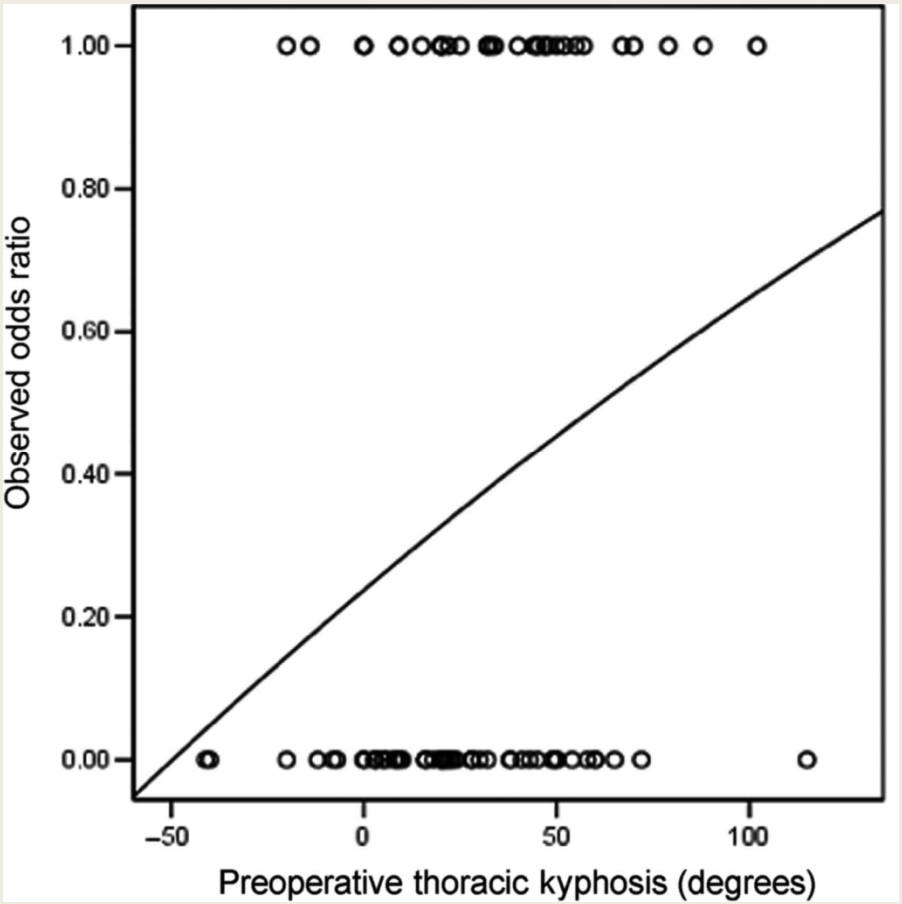
Schroerlucke et al (GSSG), 2012 Spine

90 pts, f/u 5-7yr		complic*/ #pts
K-	<10° thor kyph	12/26
N	10-40°	16/35
K+	>40°	34/29

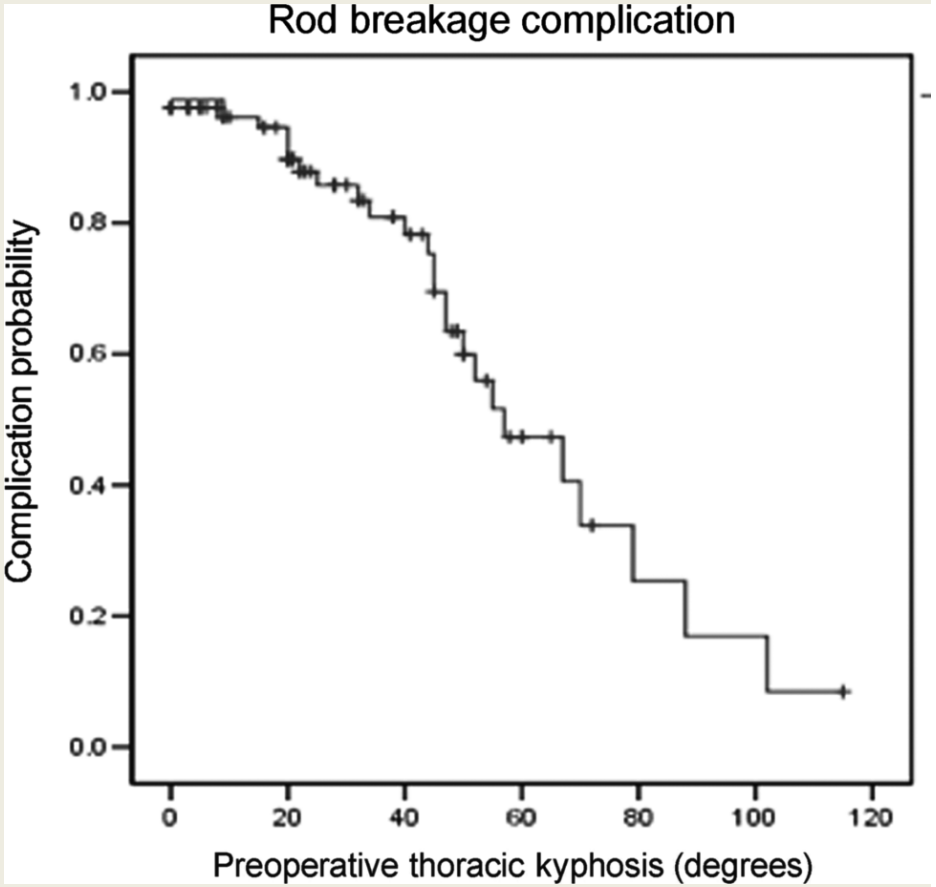
*- implant related

- Infection rate: K+ 28% N 2.8% K- 12%

Implant complications vs preop th kyph



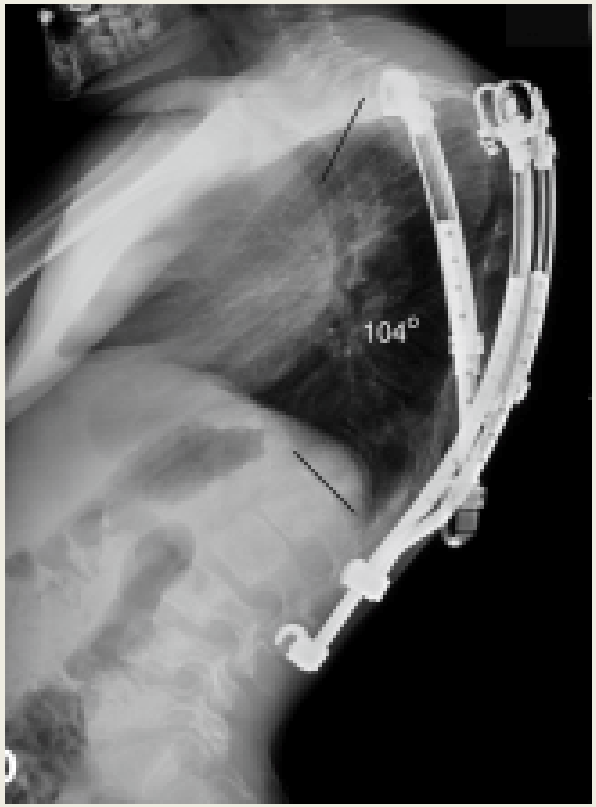
Survival curve



Proximal Anchor Failure / Kyphosis What about VEPTR ?

Reinker *et al*: Can Veptr Control Progression of Early-onset Kyphoscoliosis ?*CORR* 2011

14 pts, 5.8 yr f/u
Selection : rx plan altered to specifically treat problematic thoracic kyphosis ….normal kyphosis initially, hyperkyphosis during rx

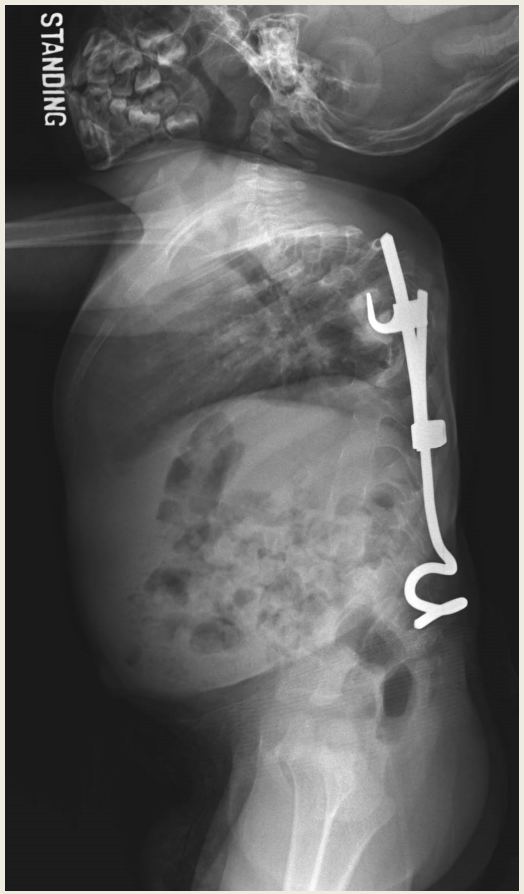


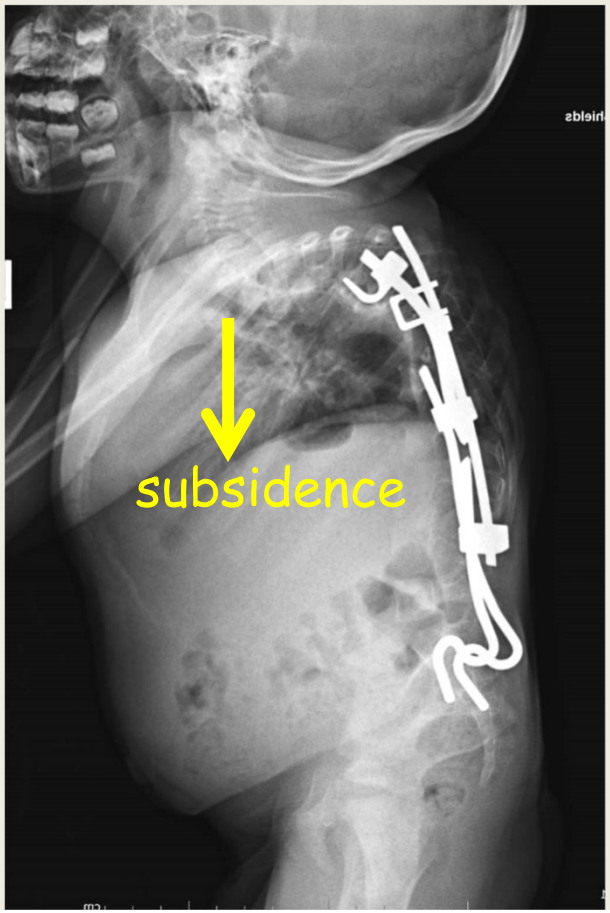
Reinker et al, 2011

- T2-12 mean kyph $68^{o} \rightarrow 91^{o}$ @ f/u
- No change in T1-5… partial p.j.k. problem
- Scoliosis curves not improved (3-16 expansions)
- Thoracic length increase 2.6 cm (-1 – 7.5)
- 7/14 req'd revision of proximal cradle
  - Cradle below 3rd rib
  - Insufficient distal anchor point (above L3)
  - Rib-rib constructs ineffective …..extend to pelvis if possible, 2nd device on opposite side

PJK w/ VEPTR

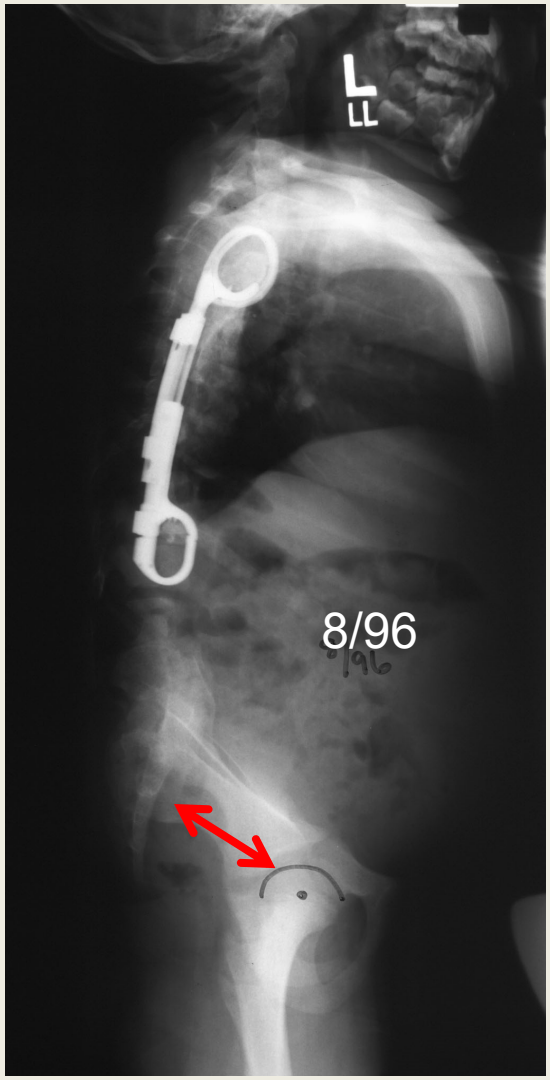
Distracting upper Th ribs doesn't necessarily move upper Th spine congruently, creates +ve sagittal balance

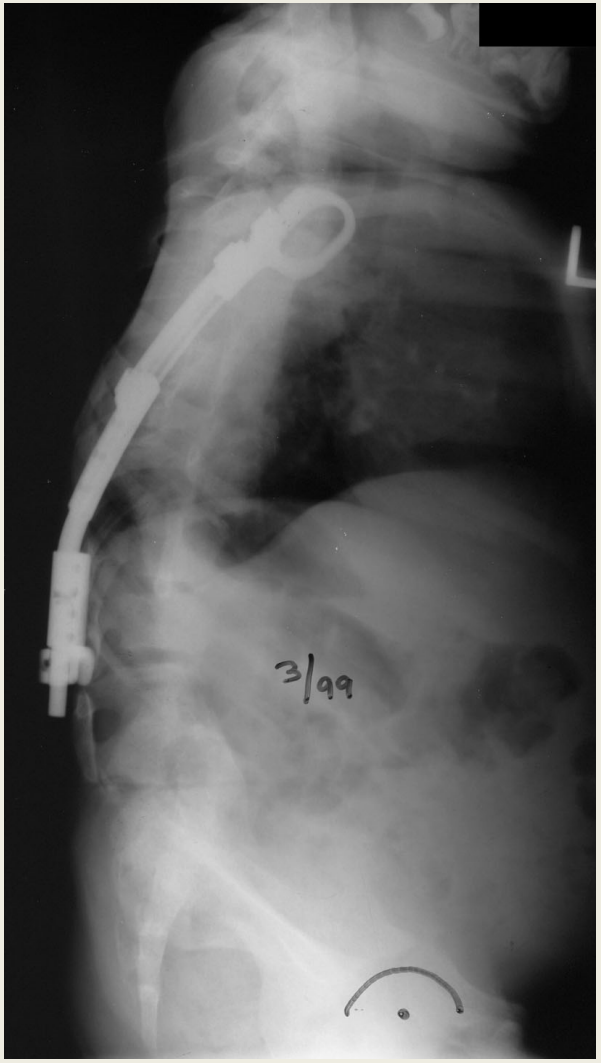


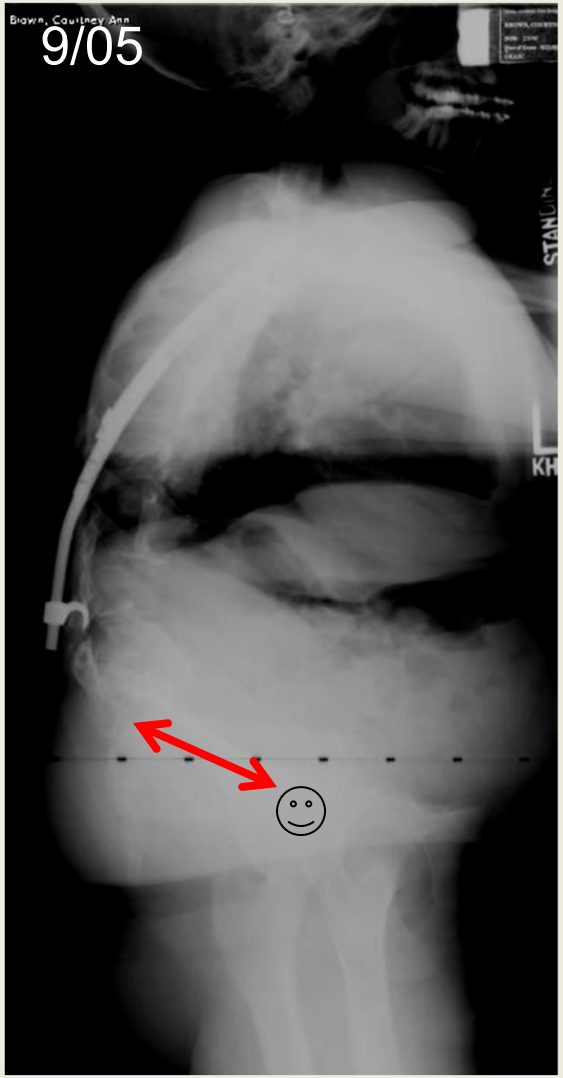


Flatback 2° repeated distractions (esp. with pelvic anchors in ambulatory patients

JT Smith, *Bilateral Rib-to-Pelvis Technique*. CORR 469, 2011

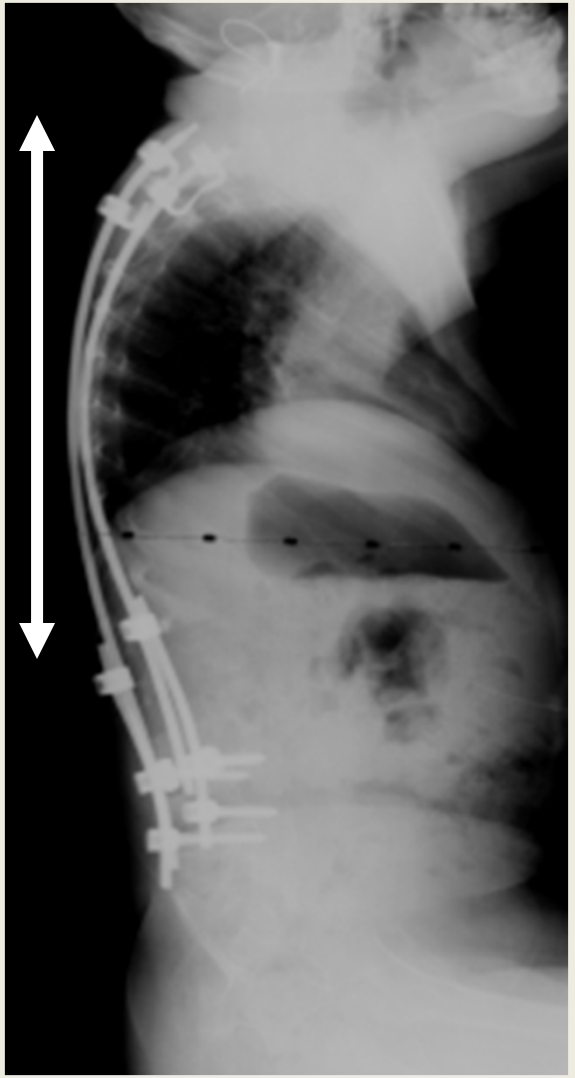




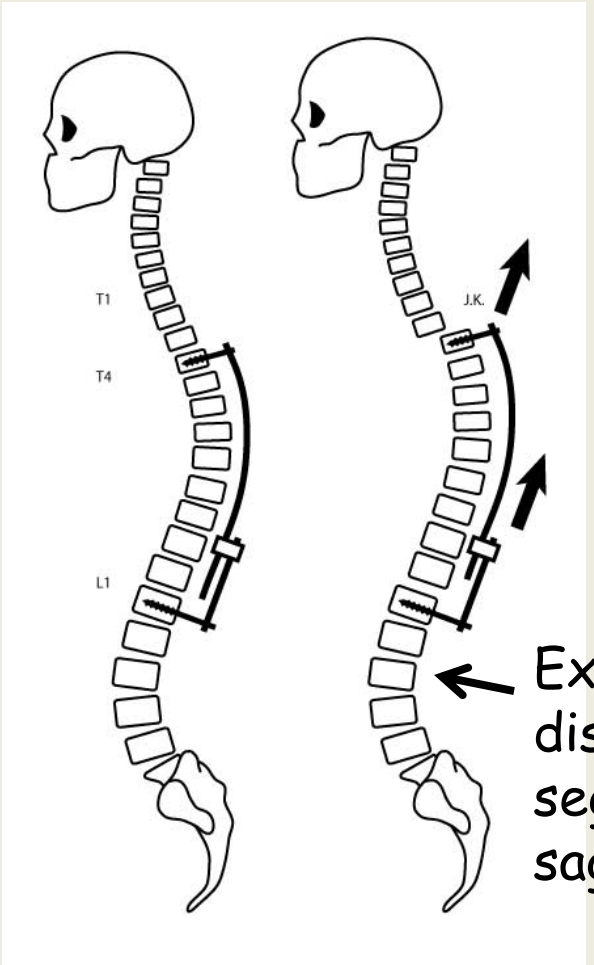


Kyphosis – biomechanically not good for distraction-based methods

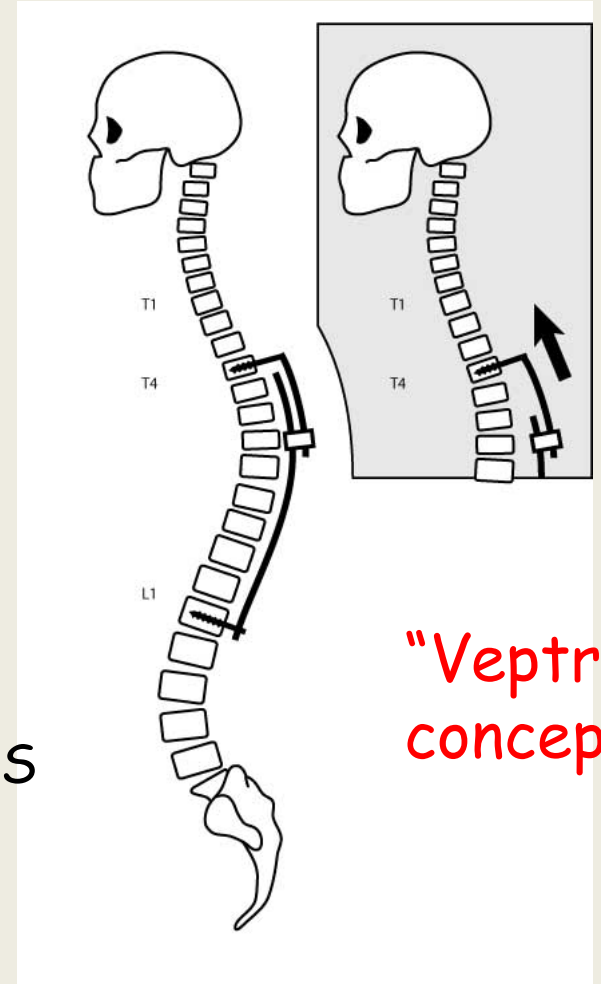
- Posterior pull-off forces large (use wires above)
- Cantilever plowing (screws) possible - ? Hooks/wires better?
- **Distraction creates kyphosis**
- **Rod contour can become inappropriate as lengthening proceeds, worsens as more kyphosis occurs**



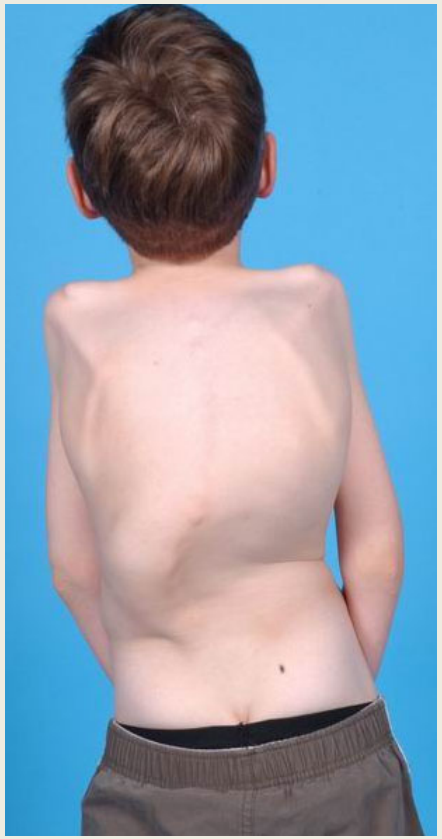
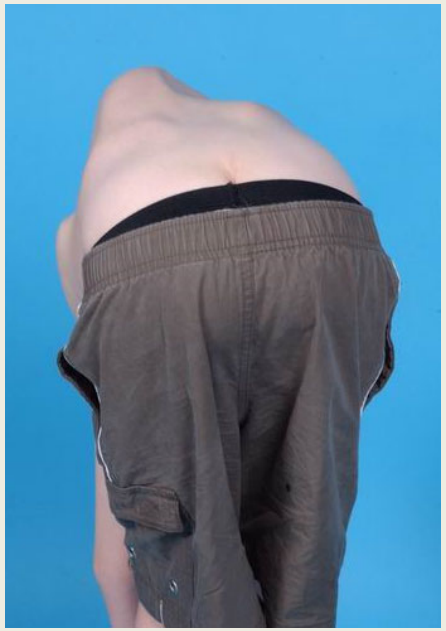
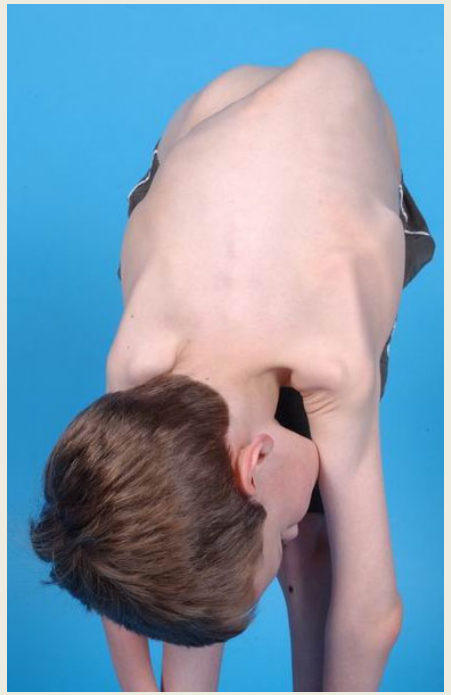
Anti-kyphosis construct – match radius of curvature of 2 rod segments to sagittal plane



Exacerbated by distraction of L-S segments -> +ve sagittal balance



"Veptr" concept

5 yo congenital myopathy

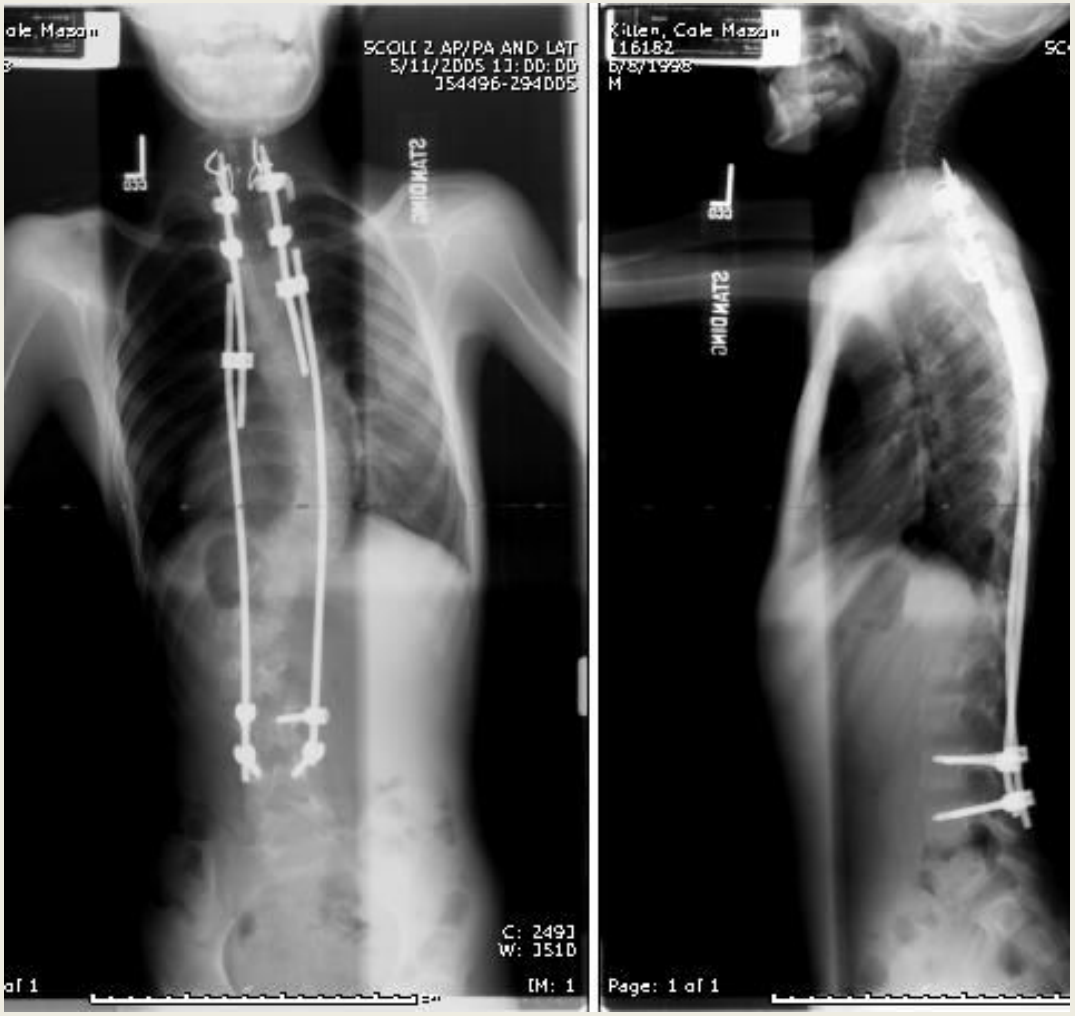
ROS benign, no significant respiratory episodes x 4 yr

Pft unable to obtain

Sat 99% RA, RR 14

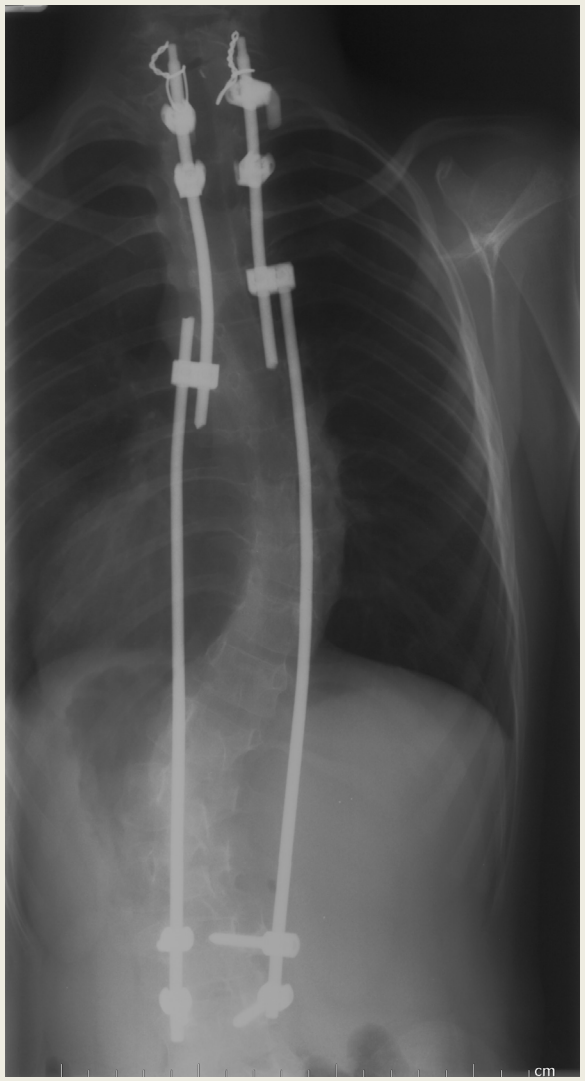
Initial xrays

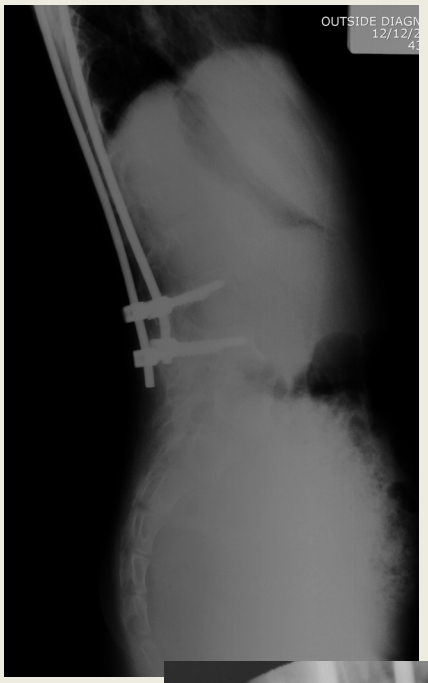
Ideal growing rod candidate ?
Anti-kyphosis construct proximally

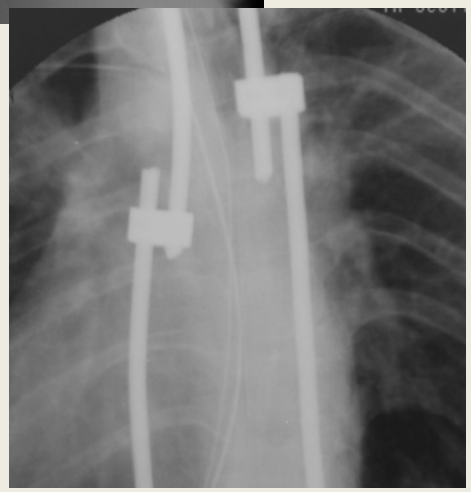


1. Fuse proximal anchors @ initial procedure – minimal distraction
2. Dominoes proximal (rod contour issue during lengthening)
3. Sublaminar backup for upper claw

2 yrs po (3 lengthenings)



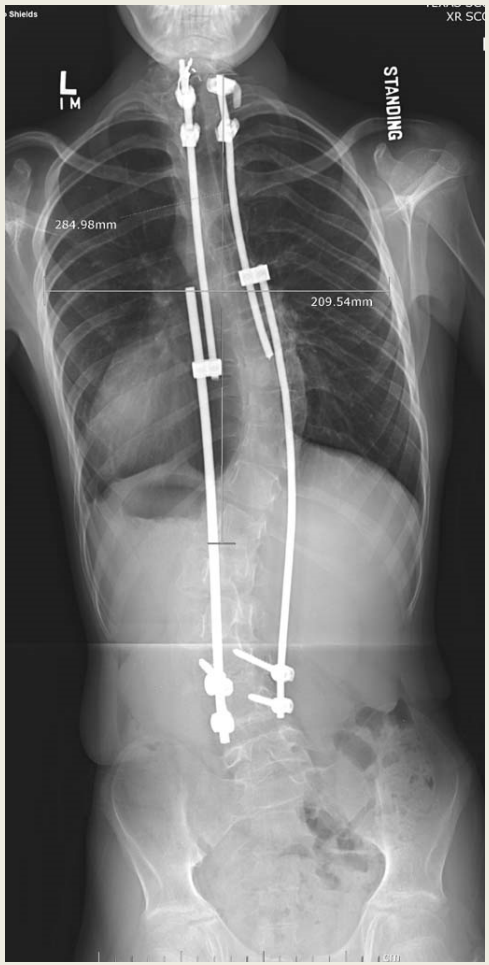


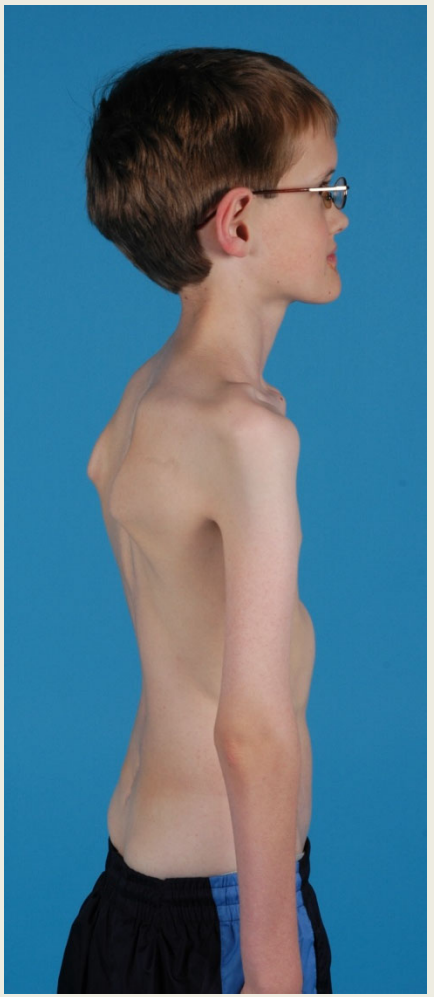


T1-12=24 cm

#4

Last f/u before fusion age 11
1 broken rod revision, T1-12 = 28 cm





Non-flexible Kyphosis – Major Cause of Proximal Anchor Failure

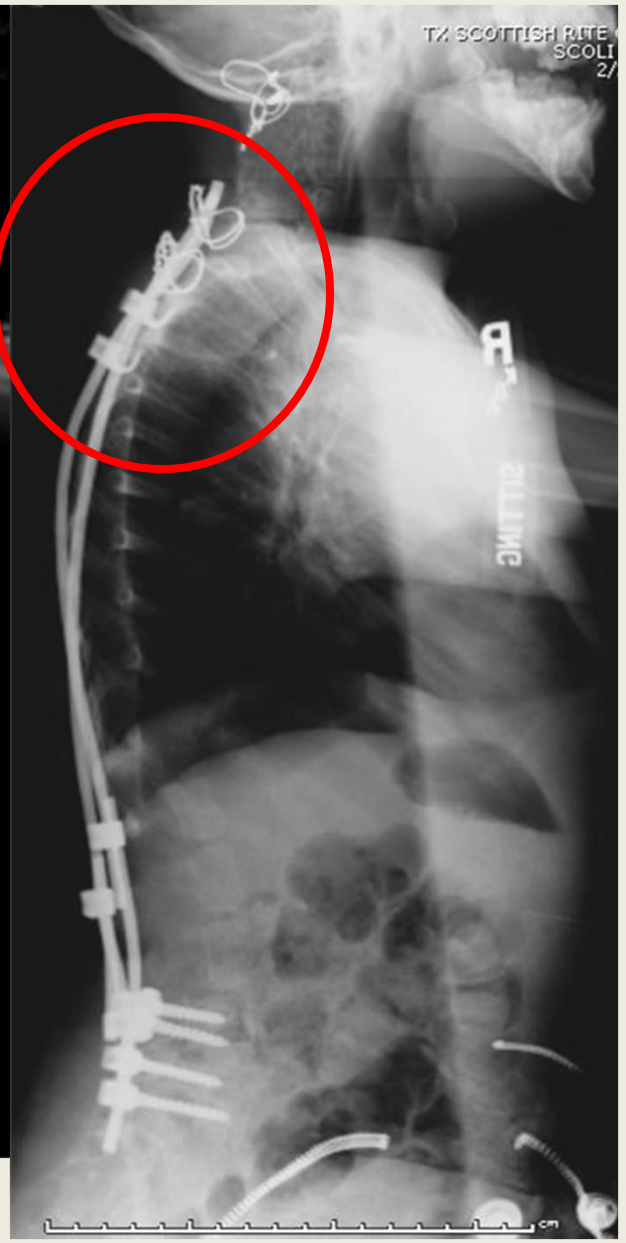
What's Changed ?

- Preop HGT to decrease deformity (Emans SRS 07)
- Instrument into cervical lordosis (not chest wall)
- Fuse upper anchors first, include T1-4/5 prn, then distract for correction @ 1st lengthening (not chest wall)

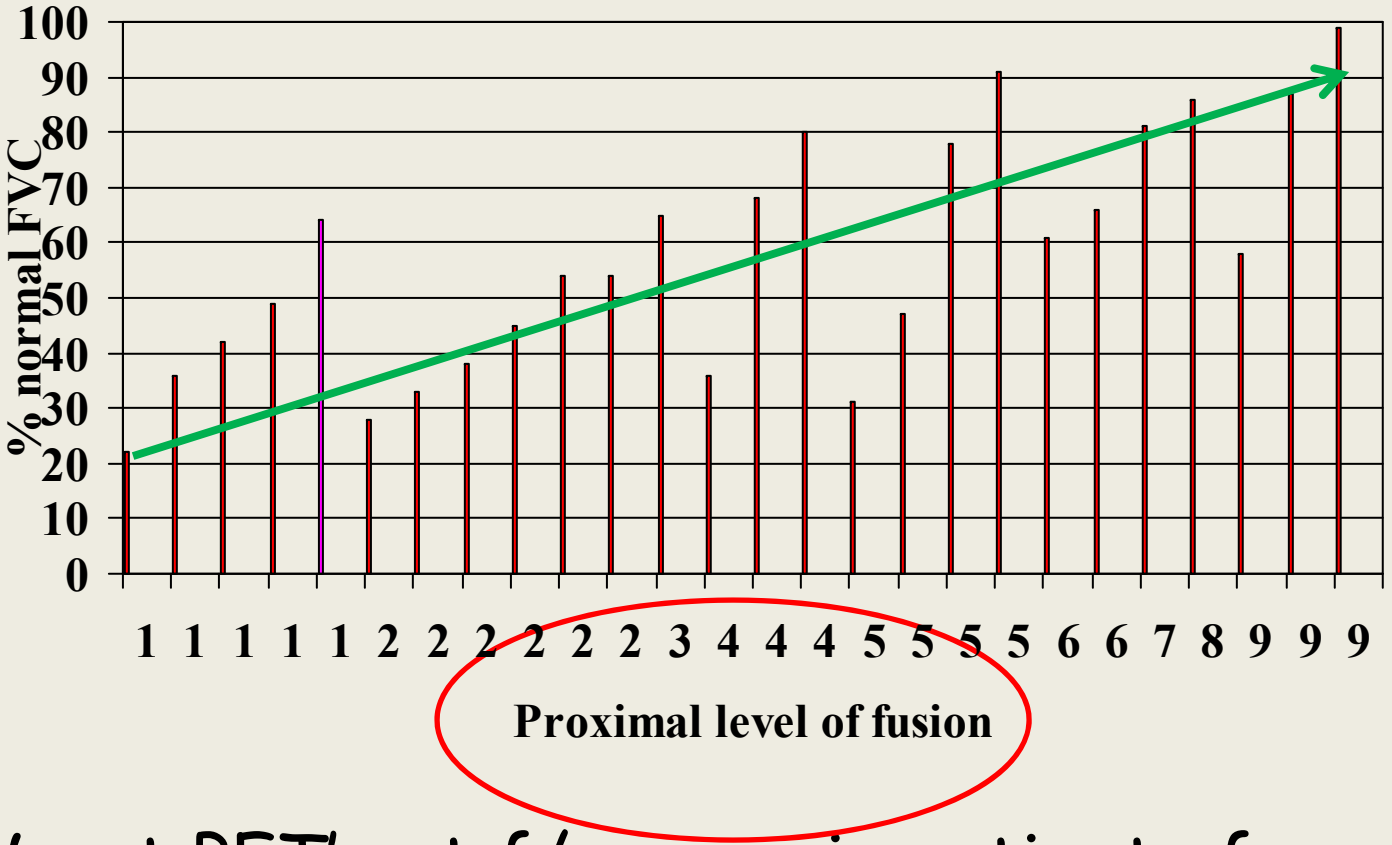
Preop

Traction x 2mo

Lengthen x4



Over-interpretation of Karol *et al*



Worst PFT's at f/u were in patients fused to T1-2……but all were fused T1/2 -> low Th or L levels = entire T spine up to T1/2

Pulmonary and Radiographic Outcomes of VEPTR (Vertical Expandable Prosthetic Titanium Rib) Treatment in Early-Onset Scoliosis

Ozgur Dede, MD, Etsuro K. Motoyama, MD, Charles I. Yang, MD, Rebecca L. Mutich, RT, Stephen A. Walczak, RRT, Austin J. Bowles, MS, and Vincent F. Deeney, MD

Investigation performed at the Children's Hospital of Pittsburgh of University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

JBJS 96-A ; Aug 2014

Are we sure we know what we're doing?

Dede, Motoyama et al JBJS 2014
Pulmonary and radiographic outcomes of VEPTR
Age 4.8 yr /11 expansions/ 6 yr f/u

	Pre-implant	1st Expansion	Last FU	P
Cobb (degrees)	80	68	67	0.002
Maximum thoracic kyphosis (degrees)	57	50	66	0.08
T1-T12 height (mm)	123	131	149	0.054
Crs/kg	1.4	1.2	0.9	0.0006
FVC (L)	0.65	0.68	0.96	<0.0001
FVC% arm	77	77	58	0.0001
SAL	0.77	0.80	0.87	0.006

T1-12=14.9 cm ……NOT NEARLY ENOUGH

(Karol et al *JBJS '08*)

Dede, Motoyama et al JBJS 2014
Pulmonary and radiographic outcomes of VEPTR

- Th kyphosis ↑ (57 -> 66 all patients)
- +ve sagittal imbalance
- ↑ high Th kyphosis
- Inverse correlation between hyperkyphosis and FVC %pred
- Similar outcomes reported by Reinker and Lattig
- **Counterpoint – most severely involved congenital spine/chest wall cases**

TSRH GR "Graduates"

paper #20

	T1-12cm	MTdeg
Preop	13.9	98
Last surg	22.8	48
Last f/u	23.9	42

Complication (rod/anchor):
7 in 4 patients

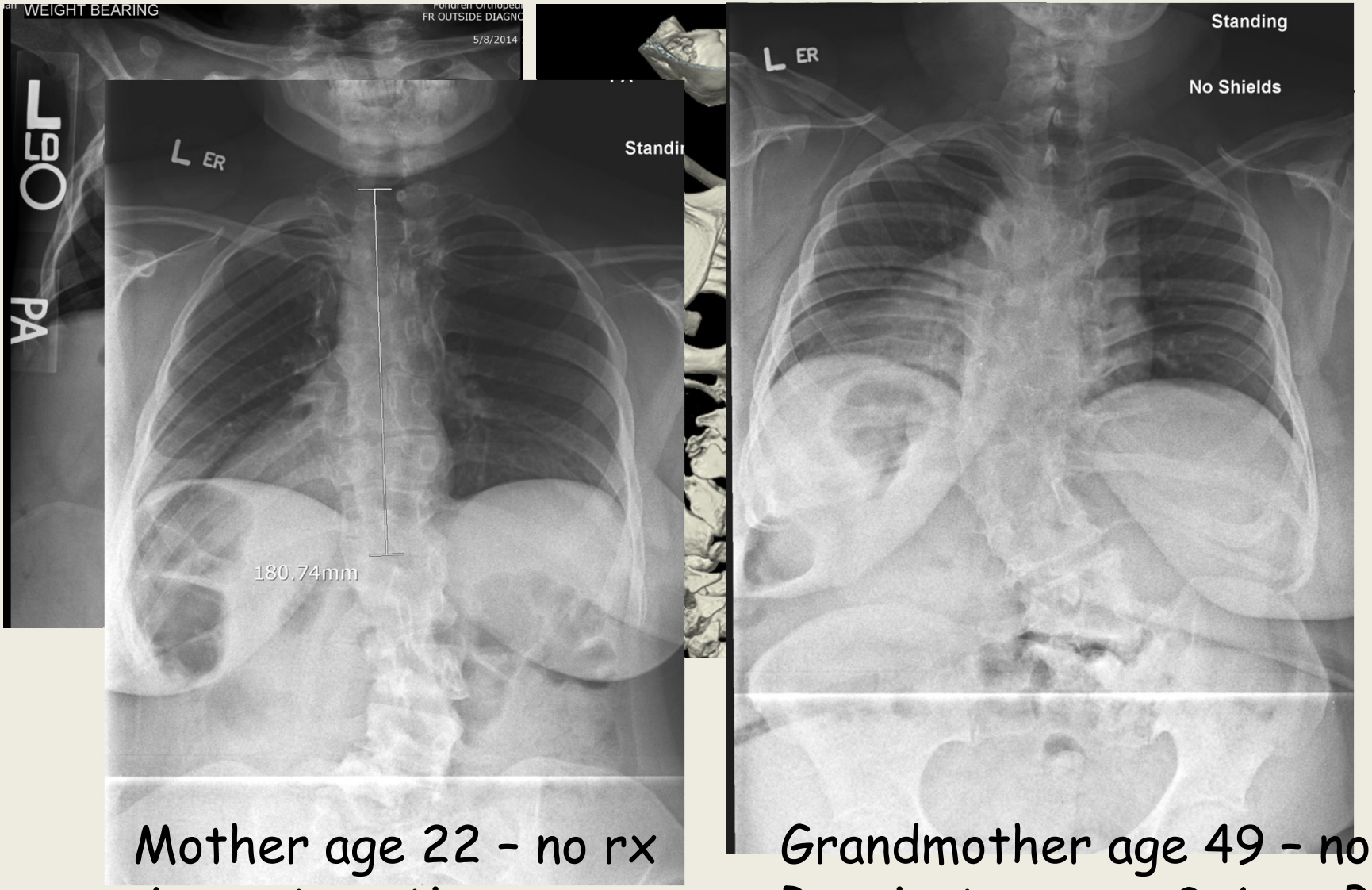
PFT	1st (6+9)	f/u (13+0)
FEV_1 (L)	.71	1.45
FEV_1 (%)	61	46.5
FVC (L)	.75	1.73
FVC (%)	62	49

Conclusions: in spite of what appears to be satisfactory thoracic length gain and curve correction during 7 year of surgical management with acceptable complication rate, pulmonary outcomes are diminished by % pred outcomes criteria.

Have pulmonary outcomes affected my practice ?

- Surgical lengthening and expansions → worrisome lack of "improvement"
- Re-assessment of early intervention in favor of delaying tactics
- **Emphasizes lack of clinically important outcome data re TIS and natural hx, especially severe congenital cases**

2 y.o. male w/ J-L



Mother age 22 – no rx
Asymptomatic
T1-12 = 18.1 cm

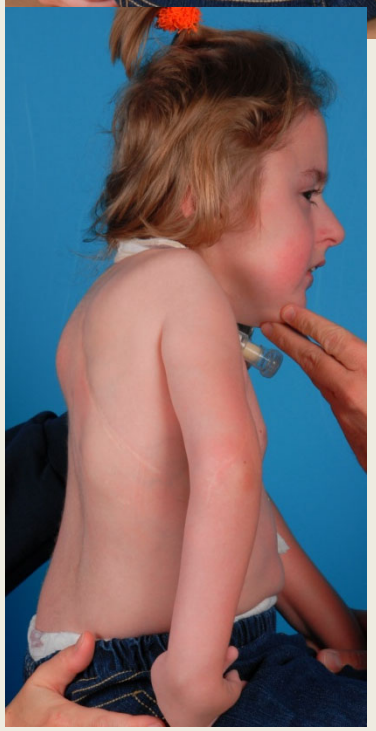
Grandmother age 49 – no rx
Respiratory sx - ? Age, BMI
T1-12 = 18.7 cm

TEXAS SCOTTISH RITE HOSPITAL FOR CHILDREN 90

www.tsrhc.org

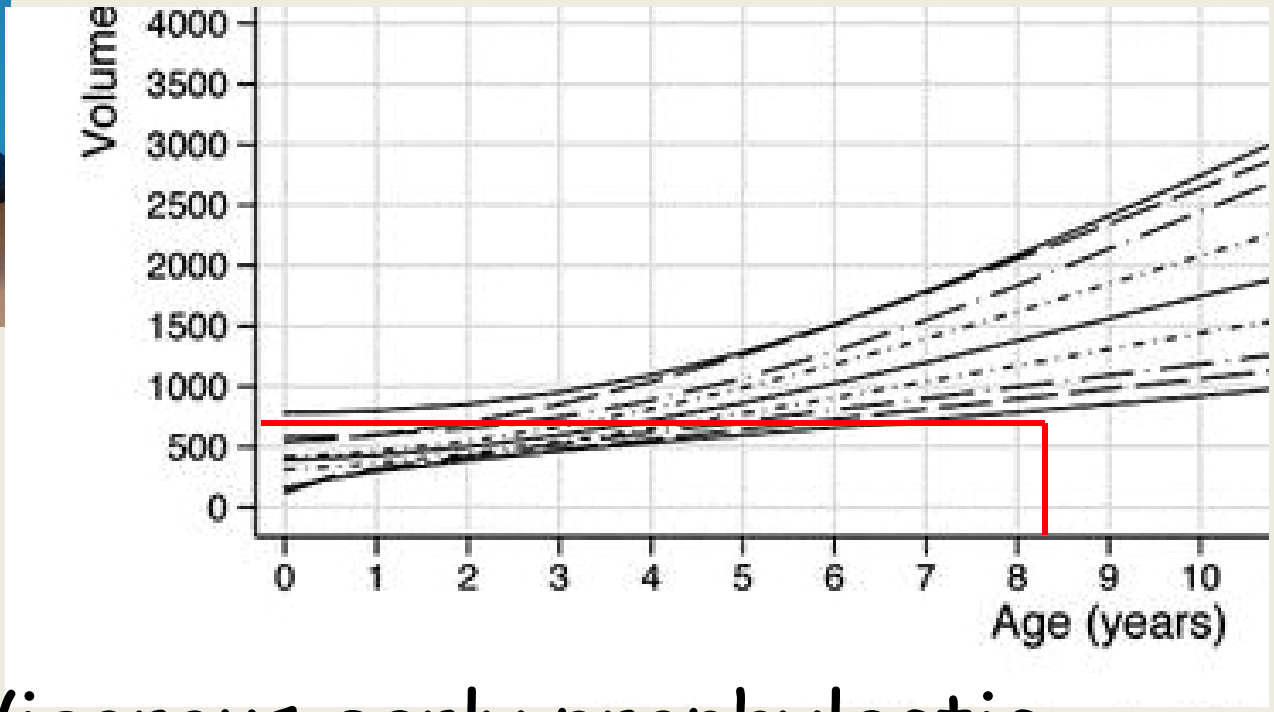
Caring for Children Since 1921

- ✓ Sagittal plane (kyphosis) problems -> use HGT + fuse in prox anchors before start
- More severe chest wall deformities (rib anchors):
- ✓ Constant surveillance for kyphosis
- ✓ Better nat'l hx info before start
- ✓ Avoid ineffective serial surgeries



Arthrogryposis

- Early vs Late Rx



Vigorous early prophylactic intervention results in CT lung vol 605cc

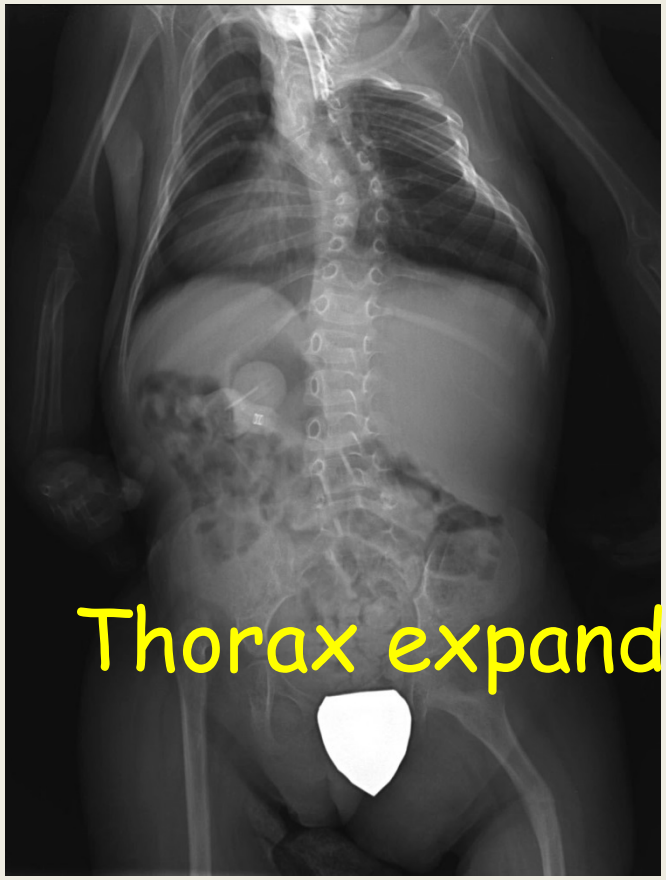
Hypoplastic thorax

TIS likely -> expansion technique

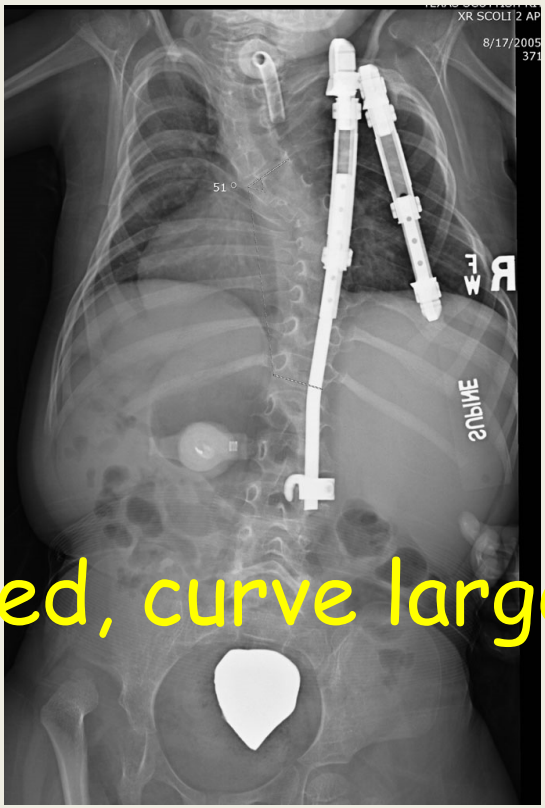
Inflexible deformity

Extra Anchors, more distraction, but…..

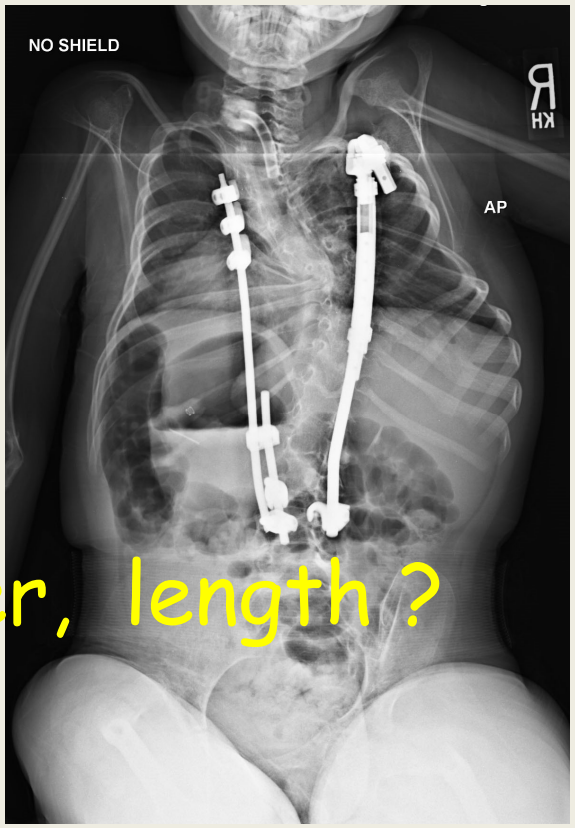
1/03, T1-12 = 14.5



8/05, T1-12 = 14.9

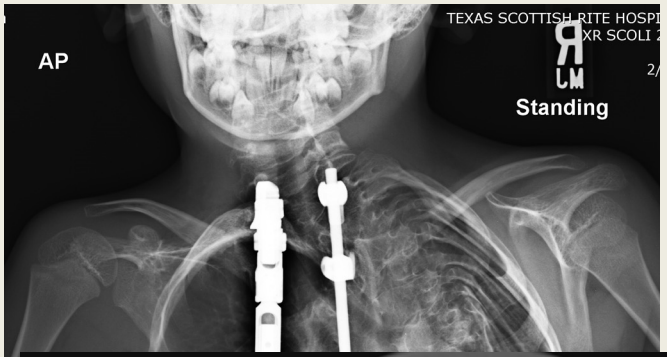


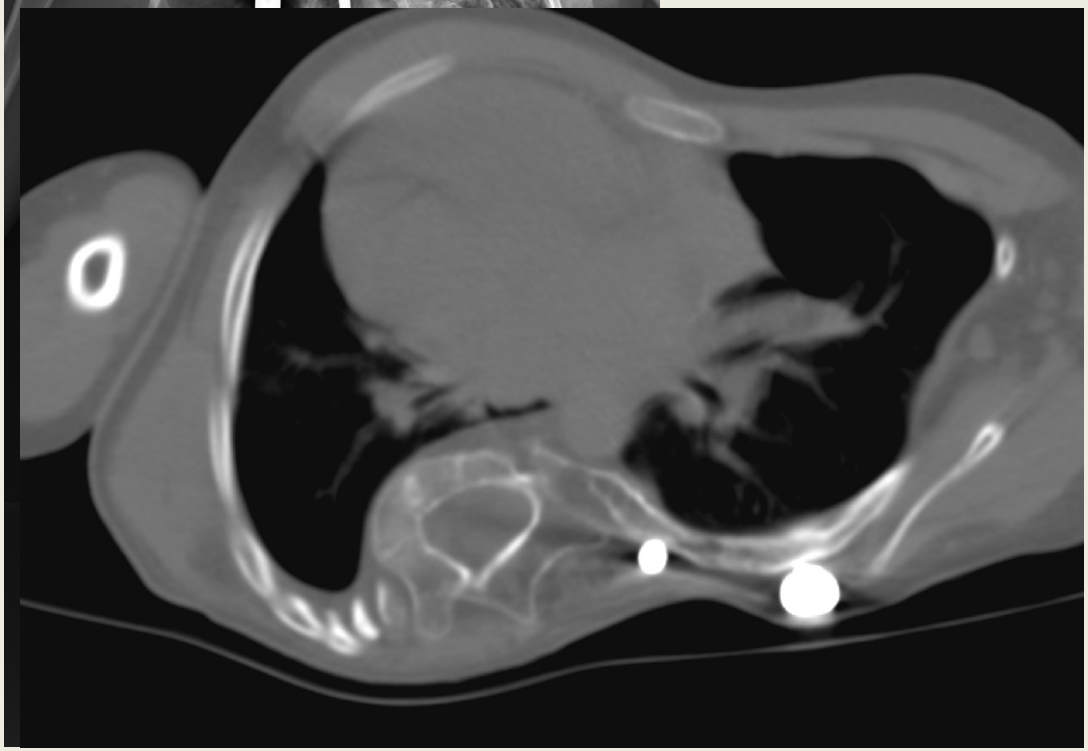
6/10, T1-12 = 15.6



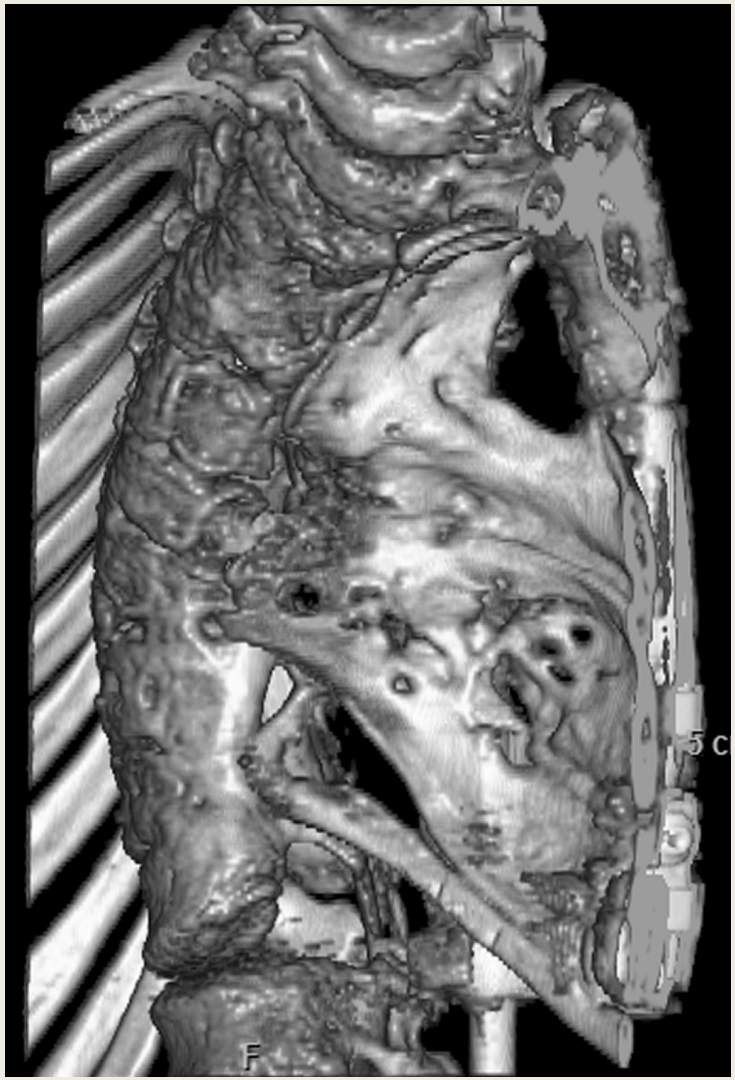
Thorax expanded, curve larger, length ?

Cong Scoli w/ rib fusions age 7 / 20 operations

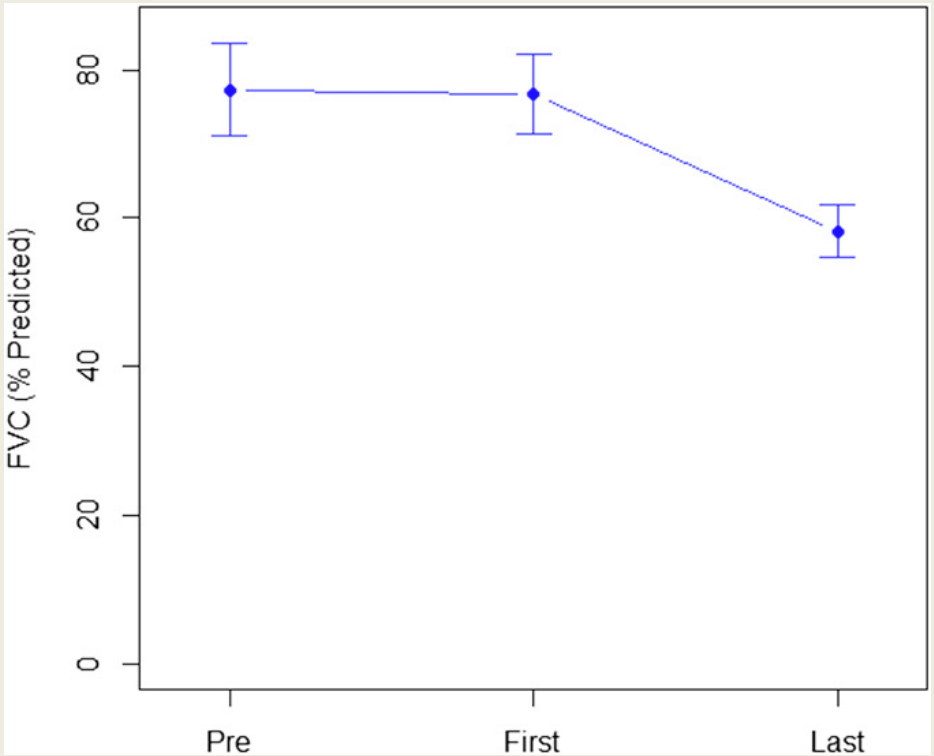


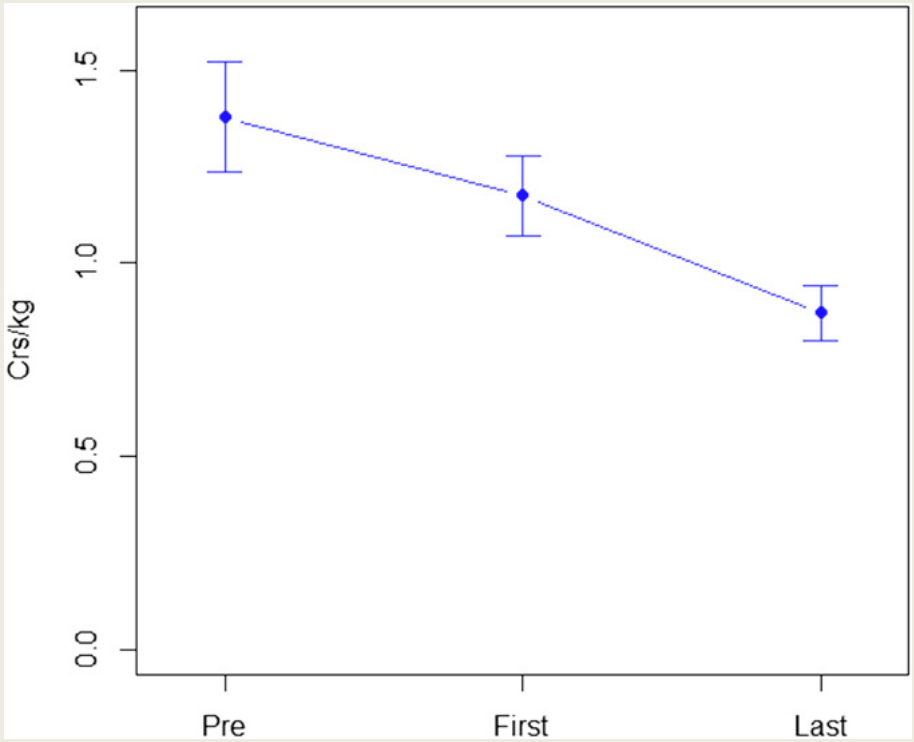


Price of "early" surgery



FVC (pred) & Lung compliance





TSRH Growing Rod "Graduates"

- 5 idiopathic-like, 1 cong, 1 amb n-m
- 74 mo 1st surgery ; 44 mo delay in 4/7
- 8 procedures (incl. initial), 1 unplanned, 6 lengthenings
- f/u age 13 yr (156 mo)
- 5 definitive fusion 1-2.5 yr, 2 obs after last lengthen 3 yrs

Initial Rx – Traction x 2 mos.