Master Technique – Growing Rods

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La Jolla, California

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SAN DIEGO CENTER
FOR SPINAL DISORDERS

GSF
Growing Spine Foundation

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Disclosures (Growing Spine)

Growing Spine Foundation (a)

DePuy Spine (a,b)

Ellipse Tech. (a,b)

K2M (a,b)

Kspine (b)

a. Grants/Research Support
b. Consultant
c. Stock/Shareholder
d. Speakers' Bureau
e. Other Financial Support

Growing Rod Technique Tips

- Patient selection
- Dual rod vs single rod
- Rod contour
- Level selection
- Subcutaneous or Submuscular
- Connectors
- Foundations (anchors)
- Lengthening and exchange
- Post-op care

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Treatment Goals

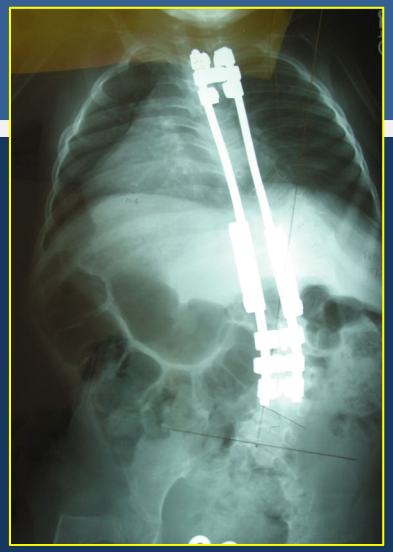
- ✓ Deformity Correction (spine and chest) and maintenance of correction
- ✓ Improve pulmonary and spinal function
- ✓ Normalize the spinal growth and avoid early fusion (maintain mobility)
- ✓ Minimize complications
- ✓ Improve quality of life and the care of the patient

ndications for Growth-Friendly Surgery

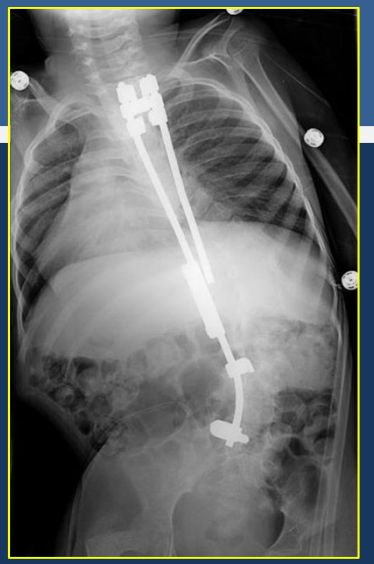
- Progressive curves not controlled or amenable to bracing or casting
- Curves where growth preservation would be beneficial
- Curves that require management of both the chest wall and the scoliosis

Significance of sagittal alignment

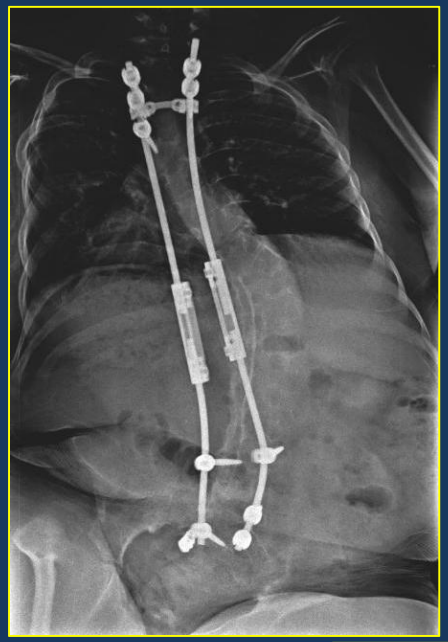
- Syndromic patients with early onset scoliosis with thoracic kyphosis over 40 degrees who undergo growing rod treatment should be monitored very closely for complications, particularly for implant failure



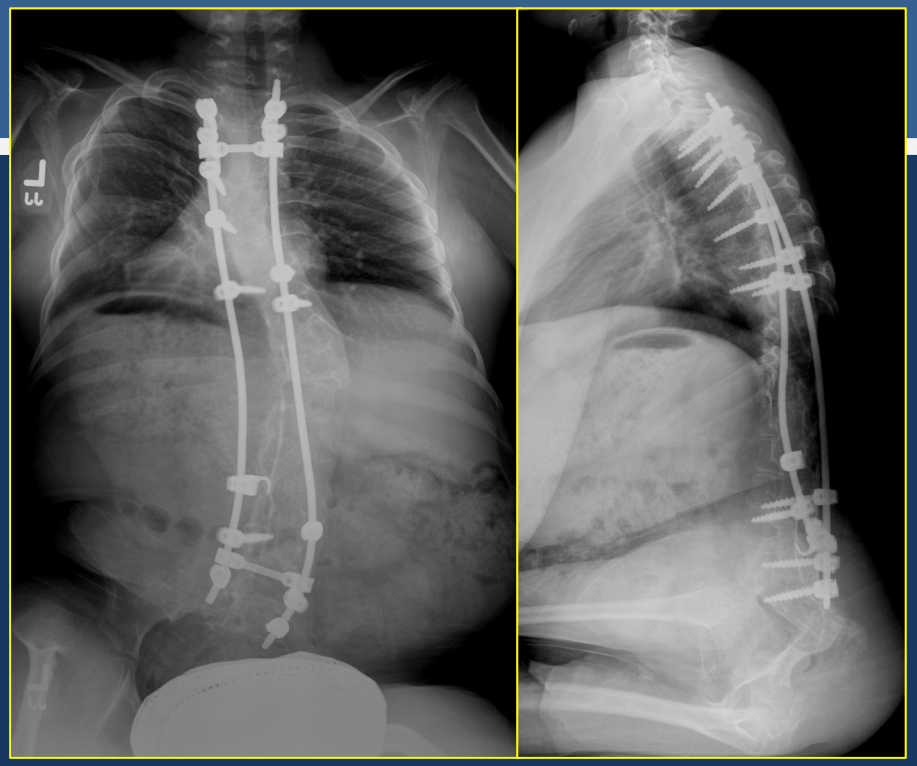
08/19/2005



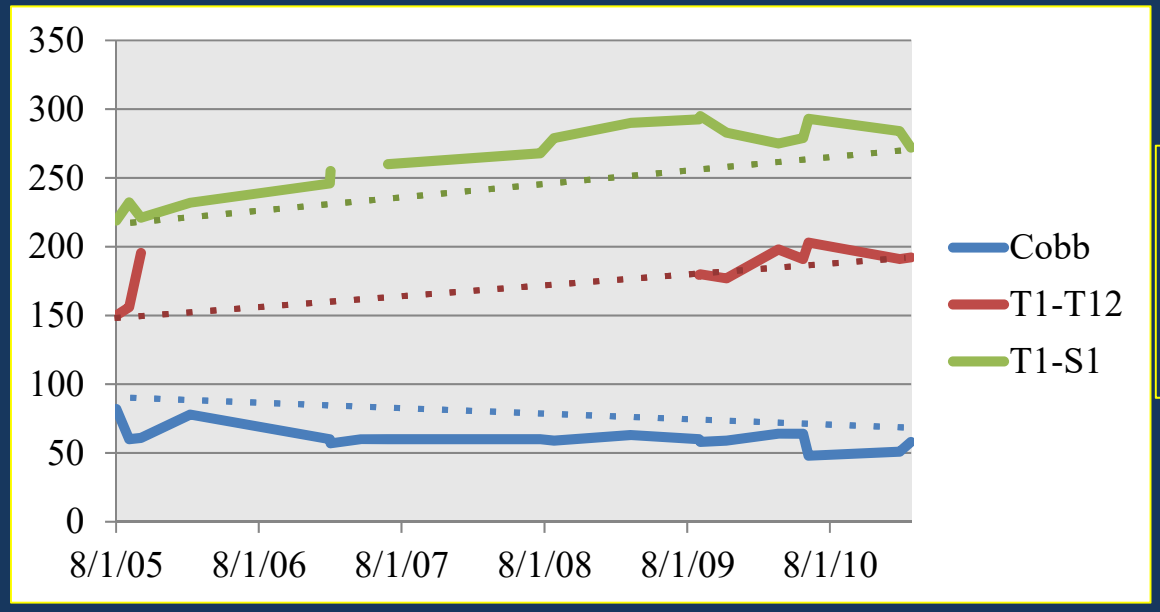
06/18/2007



9/26/2011

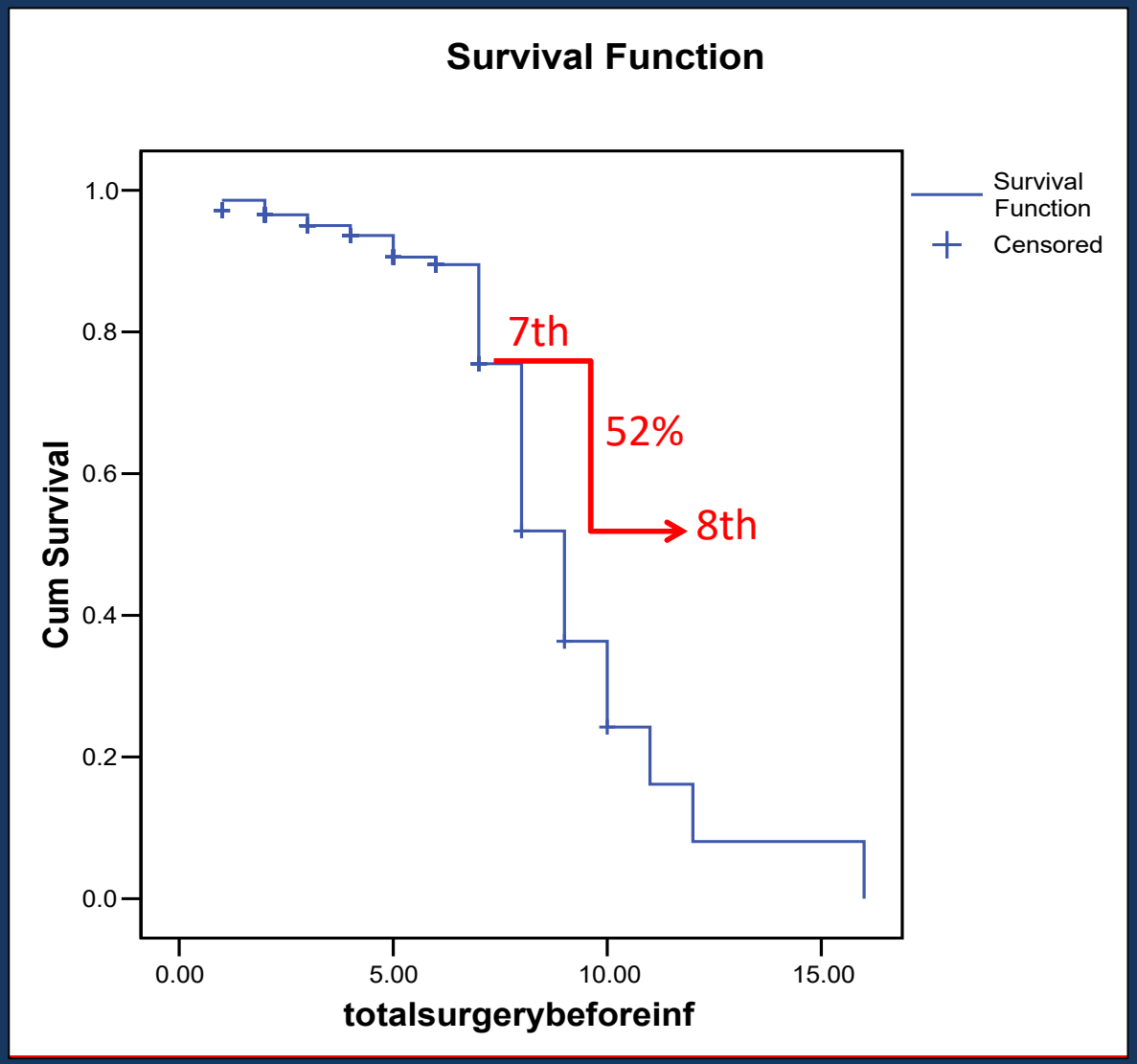


08/01/2005
Cobb 82°
T1-T12 150 mm
T1-S1 219 mm



06/04/2012
Cobb 58°
T1-T12 195 mm
T1-S1 291 mm

Cumulative survivorship dropped for 52% after 7th surgery (p<0.05)



- 13% less complications each year older child is at initial surgery
- 24% higher risk of complications with each surgery
- Length gained drastically reduced by 7th lengthening
- Weight gain occurs only in those >4yrs old

New Data Suggests Benefit to Delaying Surgery Growing Rod Surgery

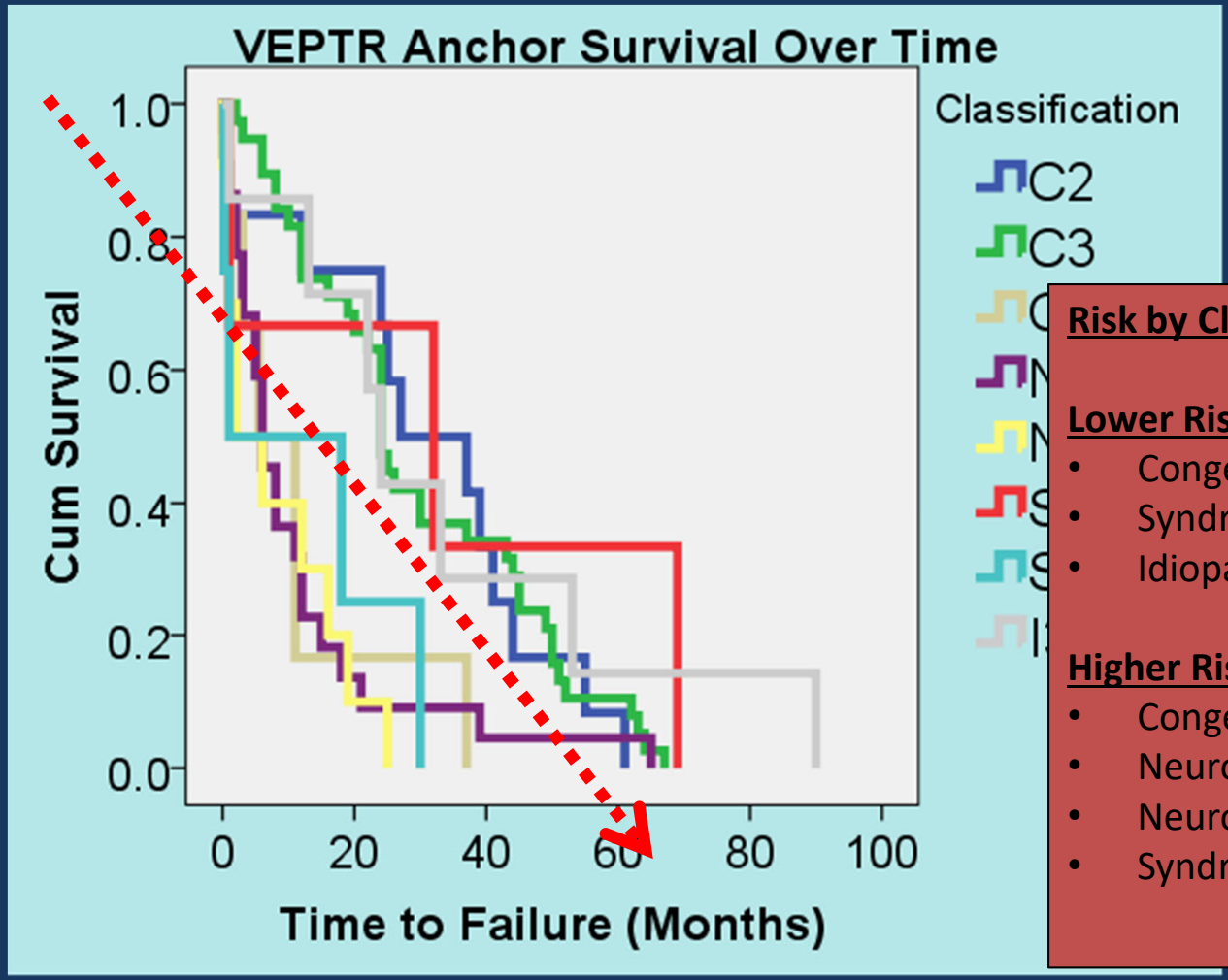
Must weigh against risk of worsening curve
Does casting delay need for surgery?

Classification of EOS (C-EOS)

Etiology	Cobb Angle	Kyphosis	APR Modifier
Congenital/ Structural	**1**: <20°	**(-)**: <20°	**P^0**: <10°/yr
Neuromus cular	**2**: 21-50°	**N**: 21-50°	**P^1**: 10-20°/yr
Syndromic	**3**: 51-90°	**(+)**: >50°	**P^2**: >20°/yr
Idiopathic	**4**: >90°		

Validation Studies

(ICEOS)



Flynn, Vitale et al.

Risk by Classification:

Lower Risk of Rapid Failure

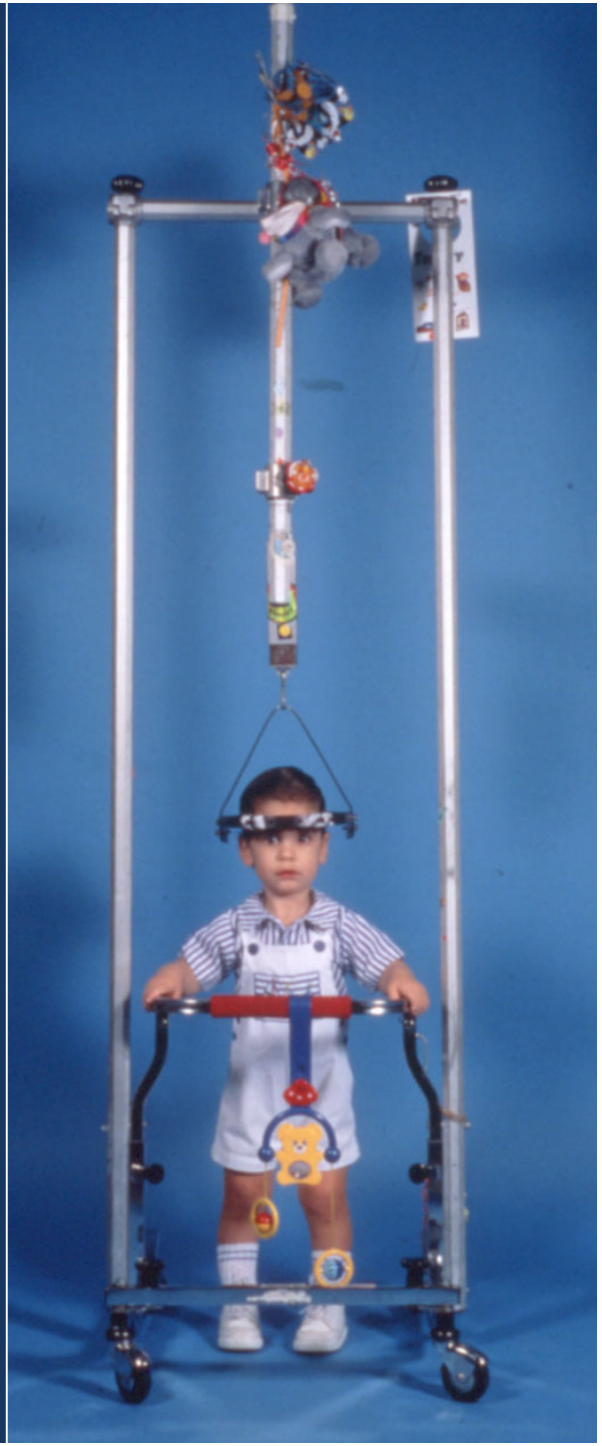
- Congenital (21-50& 51-90); C2, C3
- Syndromic (21-50); S2
- Idiopathic (51-90); I3

Higher Risk of Rapid Failure

- Congenital (>90); C4
- Neuromuscular (>51-90); N3
- Neuromuscular (>90); N4
- Syndromic (51-90); S3

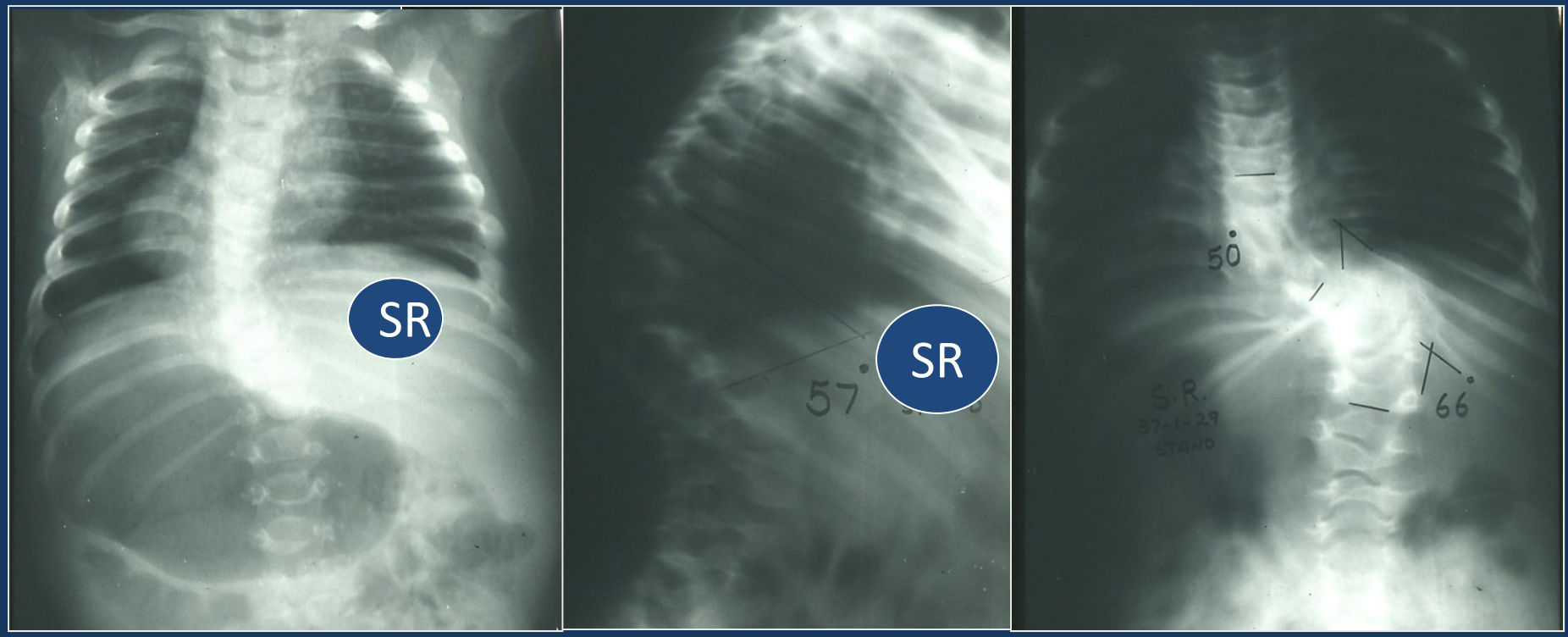
Halo – Wheelchair

Halo – Standing Frame



C. Johnston TSRH

Conradi's Disease

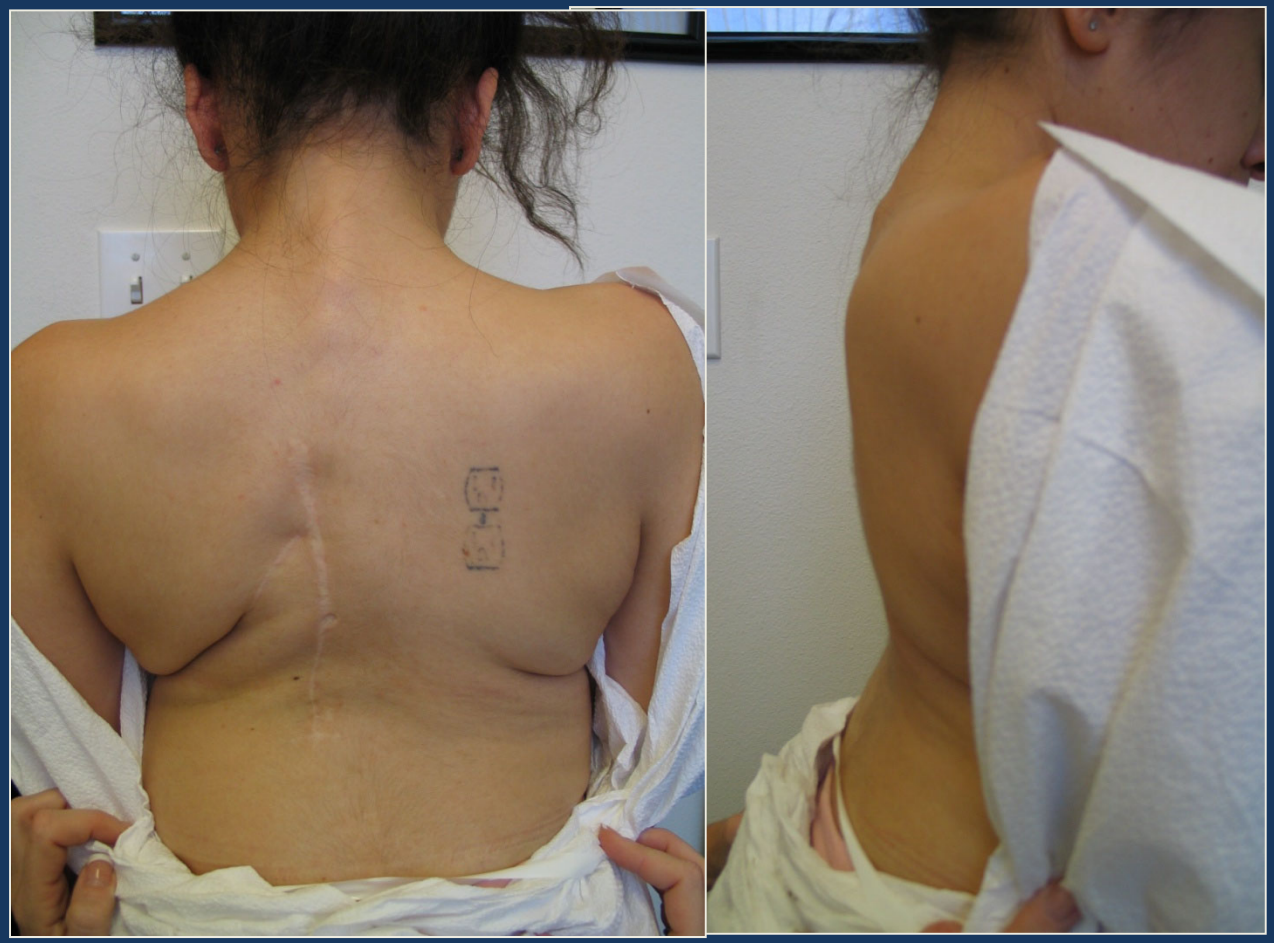


11 Months

20 Months

SR – AGE 2 PRE-OP

SR - 28 YARS POST-OP



SR Age 32

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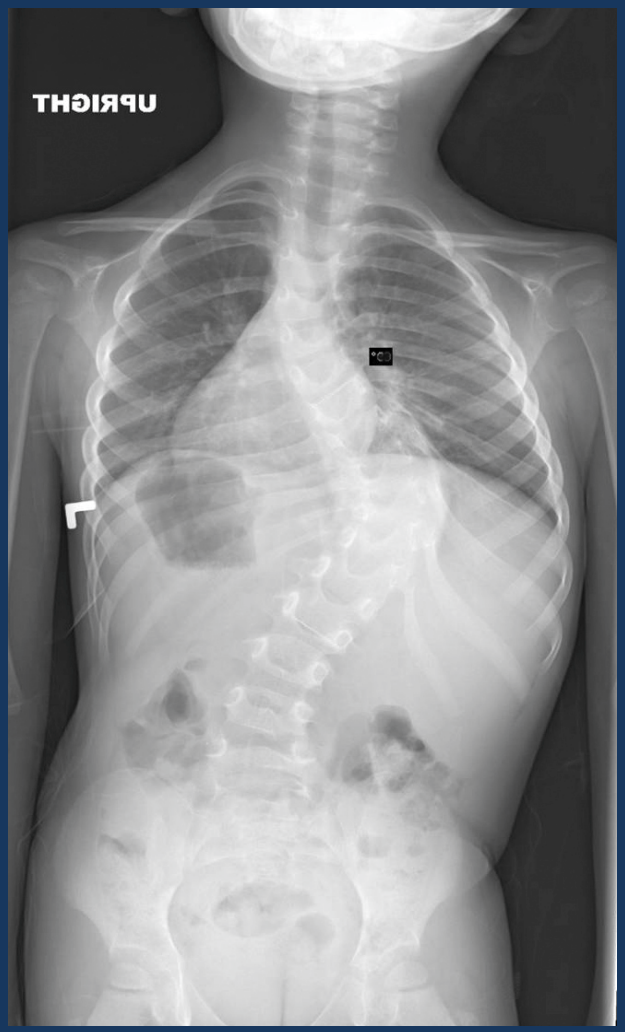
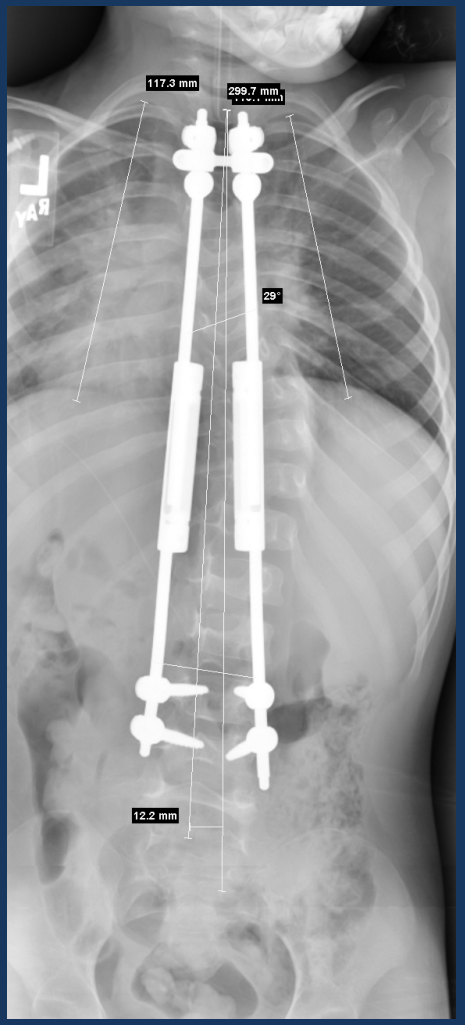
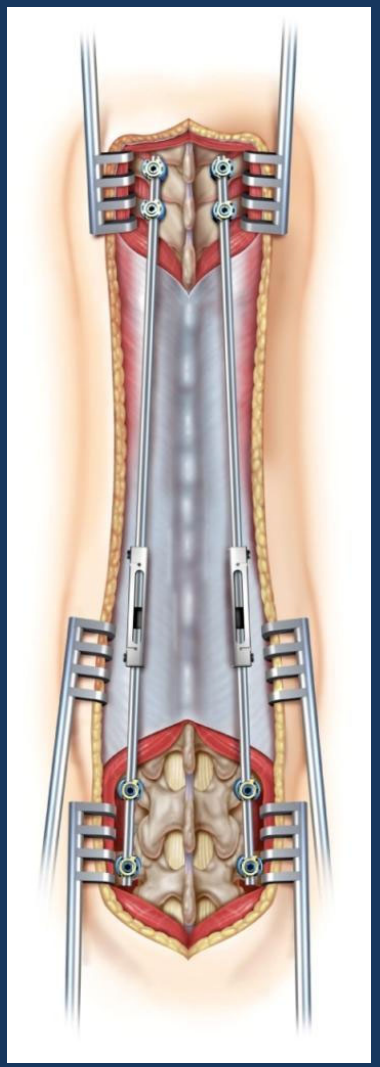
Growing Rods





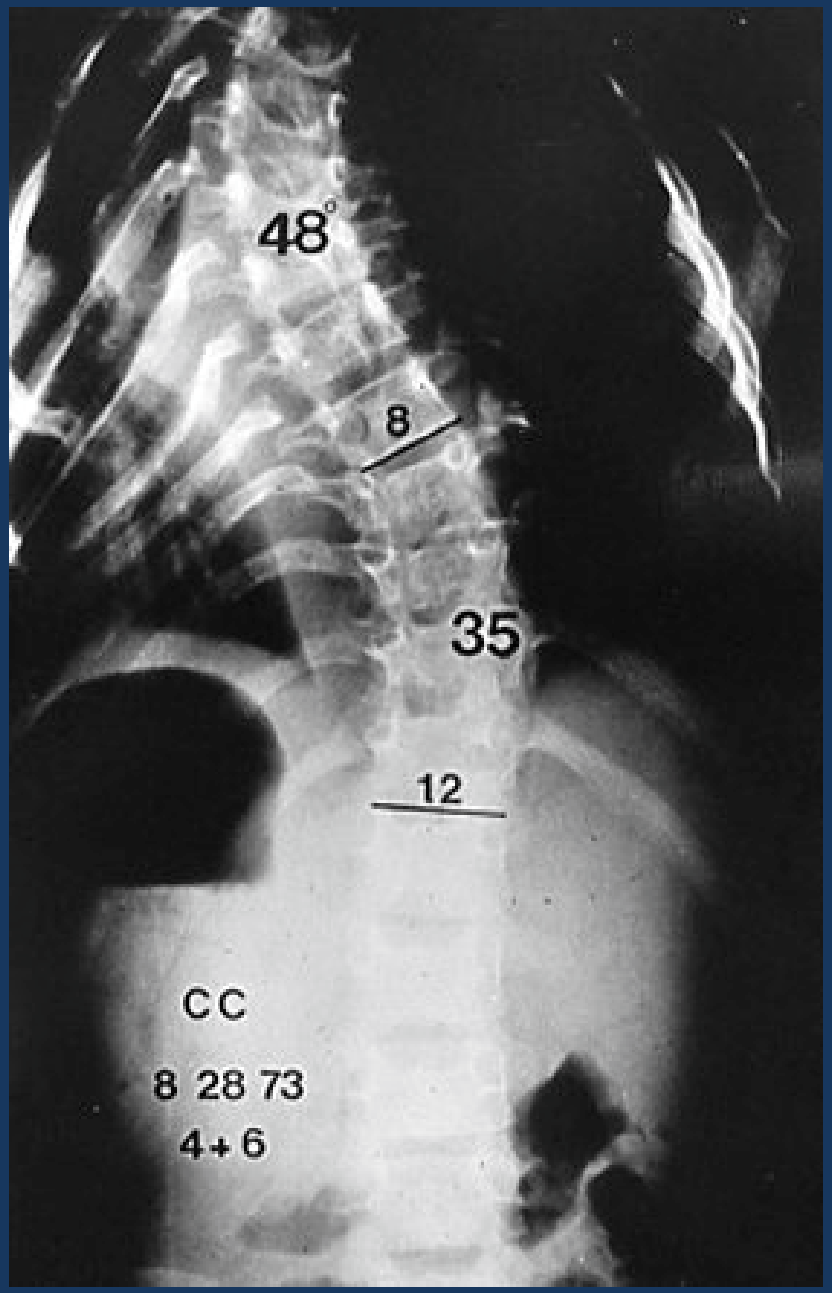


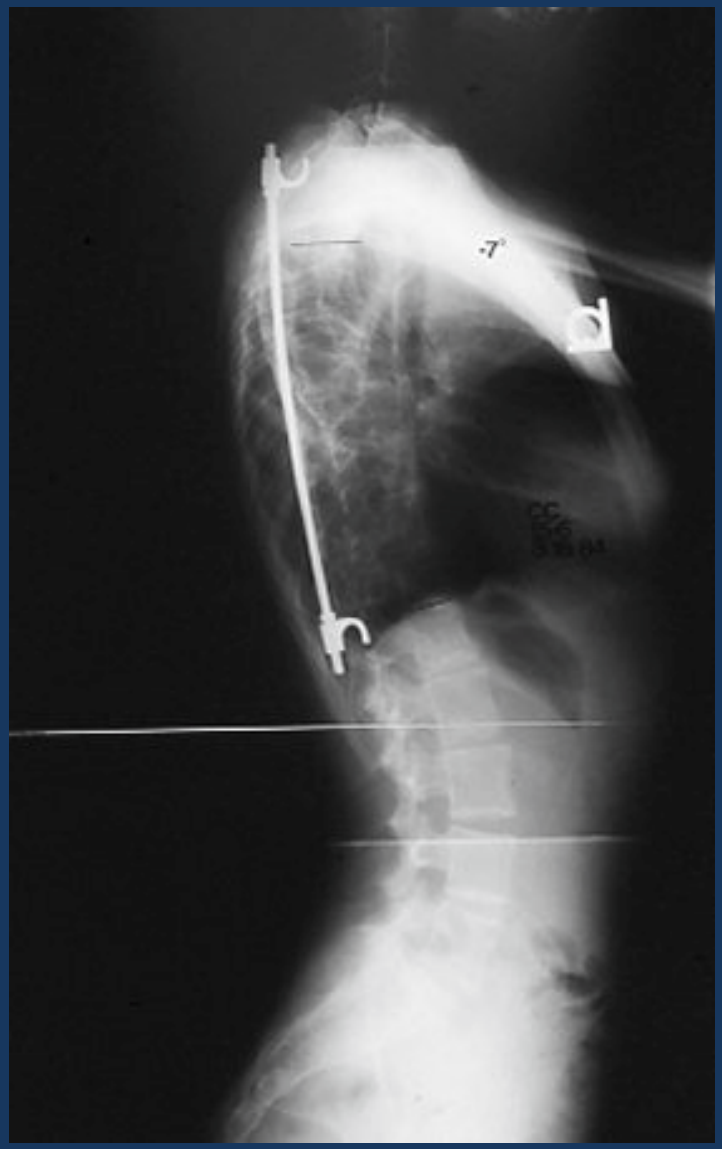
RESULTS (cont'd)

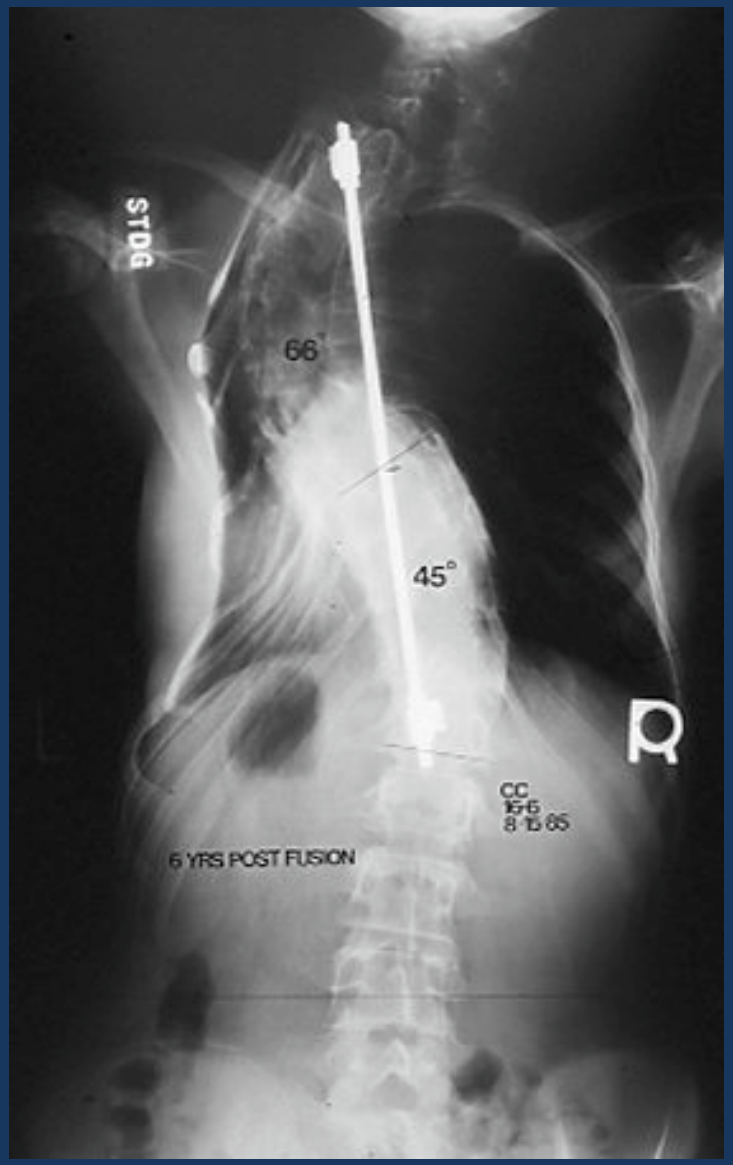
GROUP	Cobb Angle *(Pre-Initial to Post Final)*	% Correction	Increase in T1-S1 Length
Single with apical	85° → 65 °	23%	6.4cm
Single w/o apical	61° → 39 °	36%	7.6cm
Dual w/o apical	92° → 26°	71%	11.8cm

First Patient at TCSC
NF1

Courtesy of
Robert Winter, M.D.

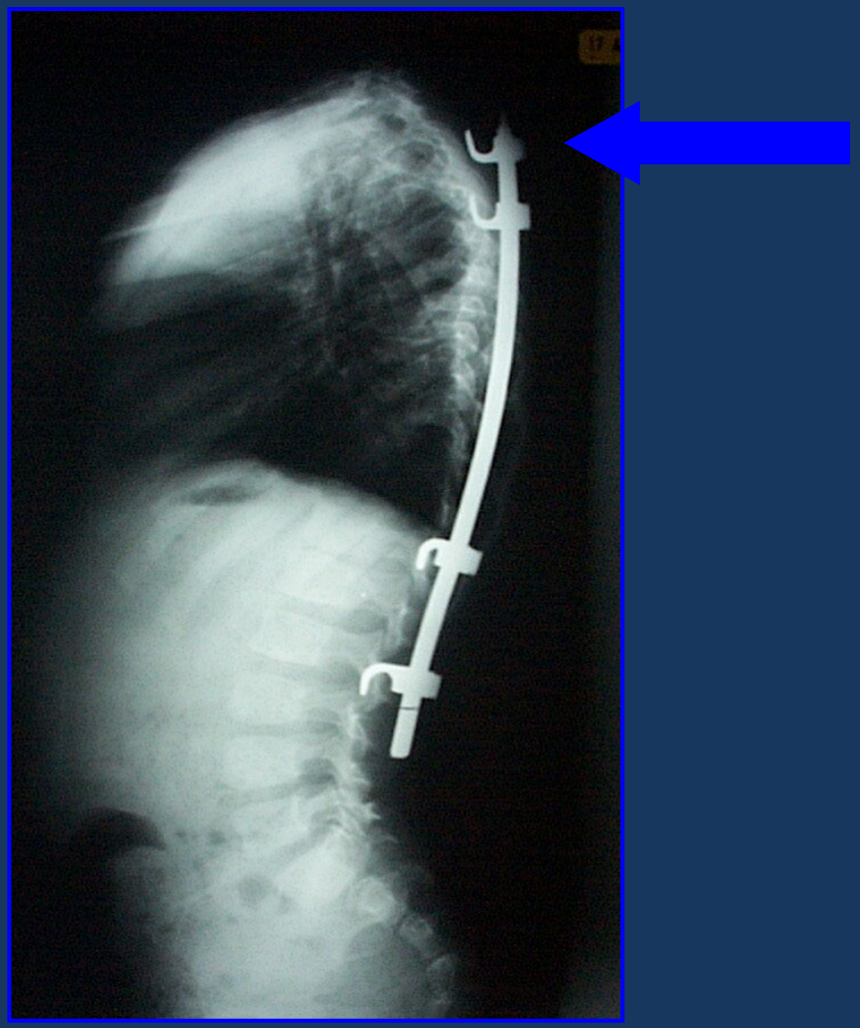






Six years after fusion, now age 16

Hooks



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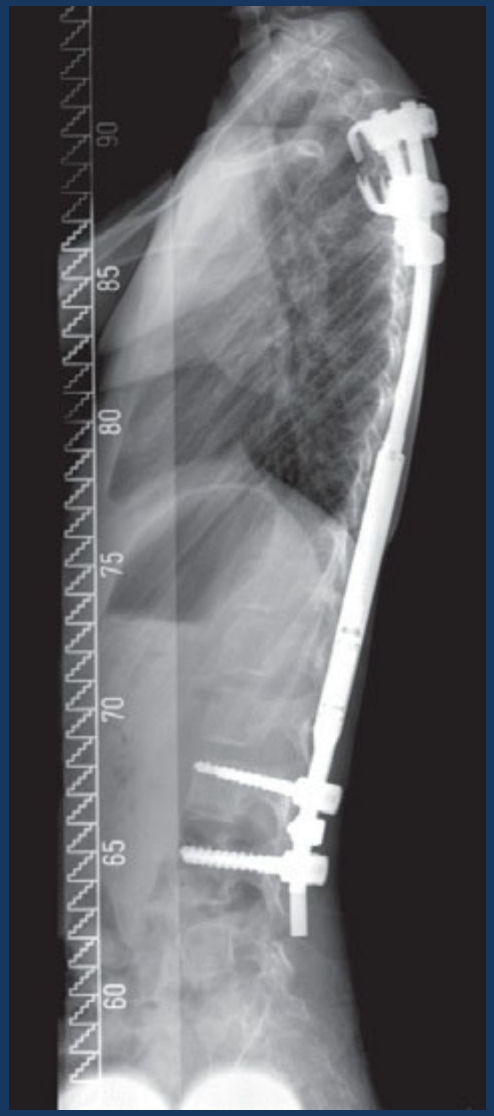
MCGR (Case 1)



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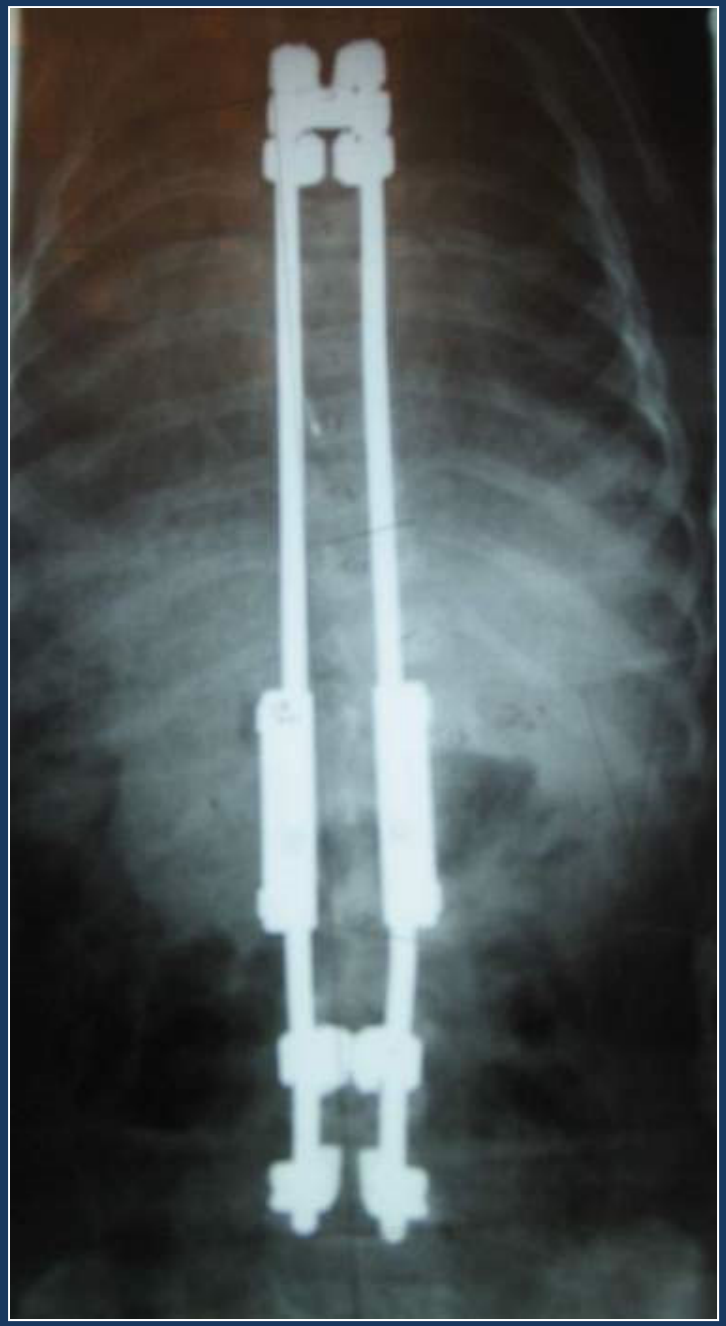
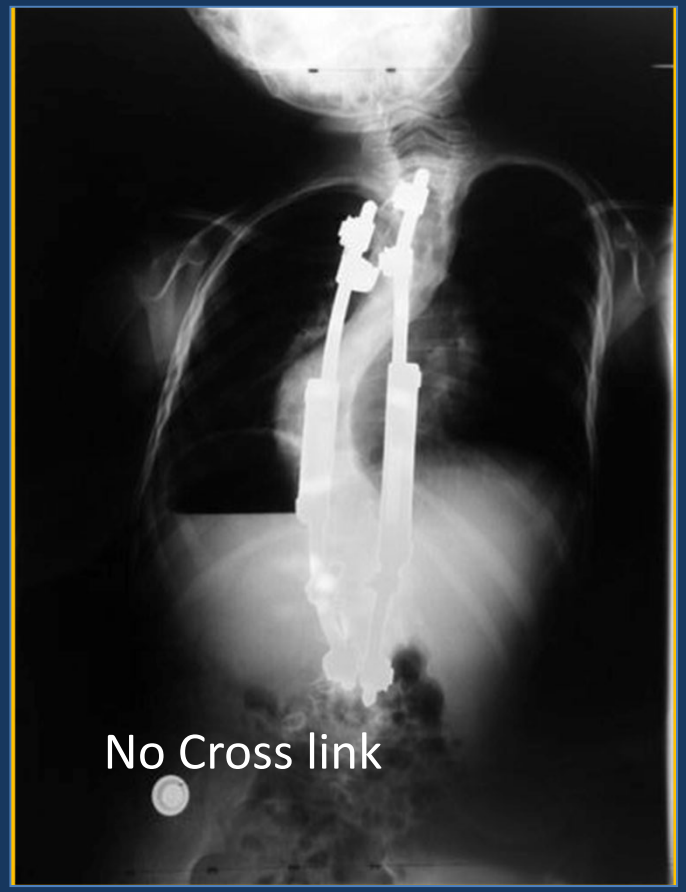


Poor Selection of Instrumentation levels

At age 6 y.o and 2 years after growing rod insertion



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- Underwent first lengthening 6 months later
  - Post-op evaluation were normal
  - Curve T10-L2: 42 degrees
  - T1S1: 291 mm

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Options

- Anchors
- Hooks
- Screws
- Wires
- Cradles
- Tapes
- Combinations

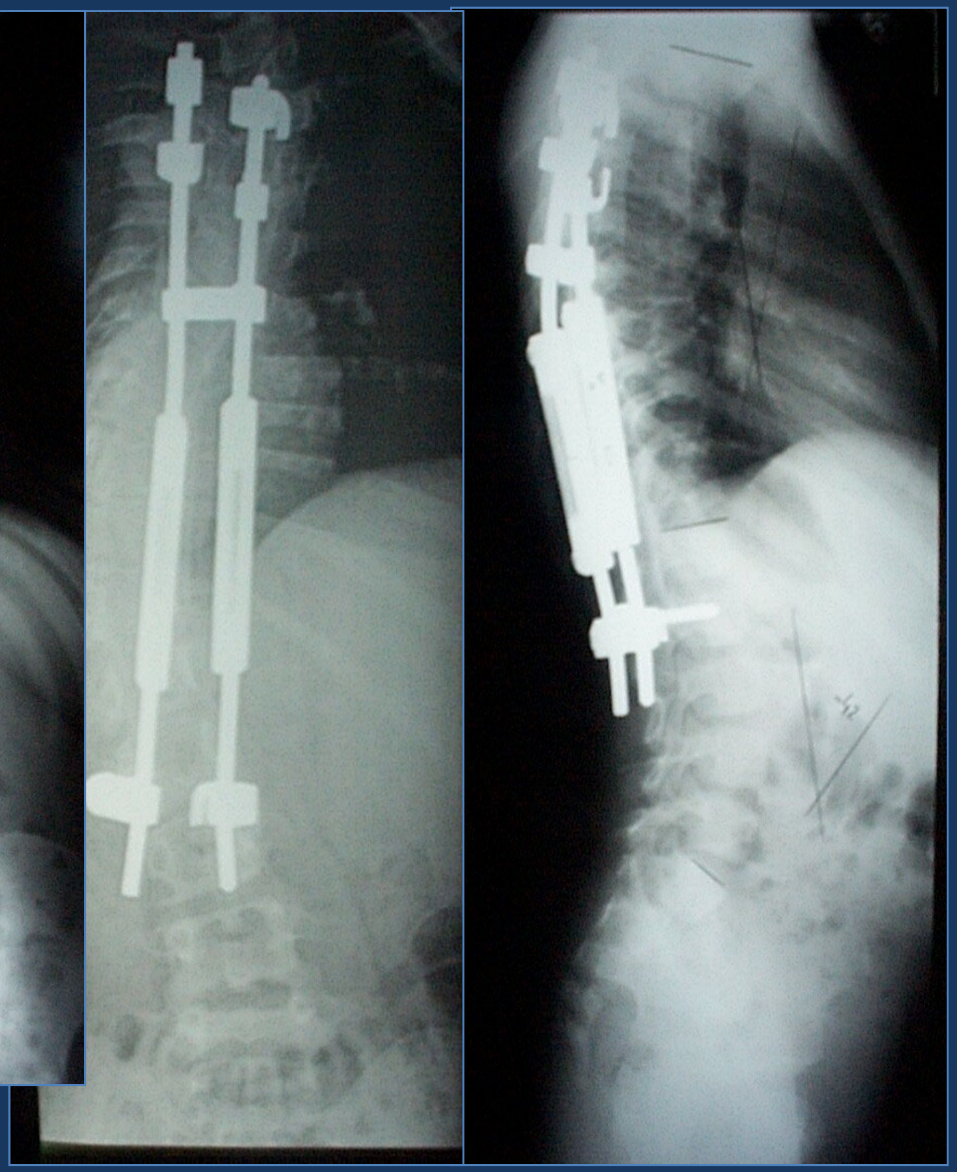
- Sites
- Laminar
- Transverse Process
- Pars
- Pedicle
- Rib
- Combinations

David Marks

N.O. 5+11 Girl (IIS)

Scoliosis:	
Pre-op	90°
Post-op	55°
T1- S1(mm):	
Pre-op	224
Post-op	273
FU	331
Elongation	4.9
Growth	5.8
Total	10.7 cm
1.2 cm	per year

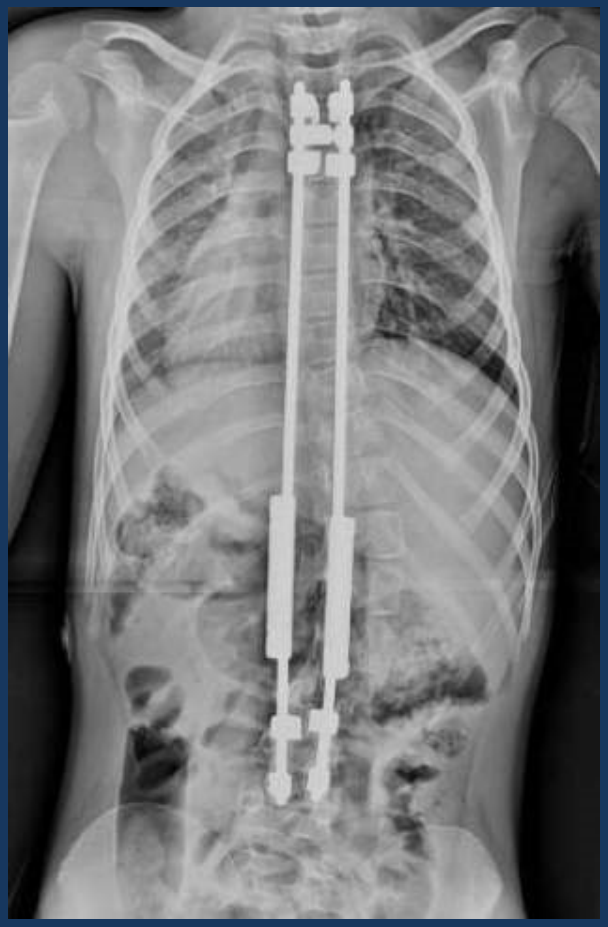
Preop



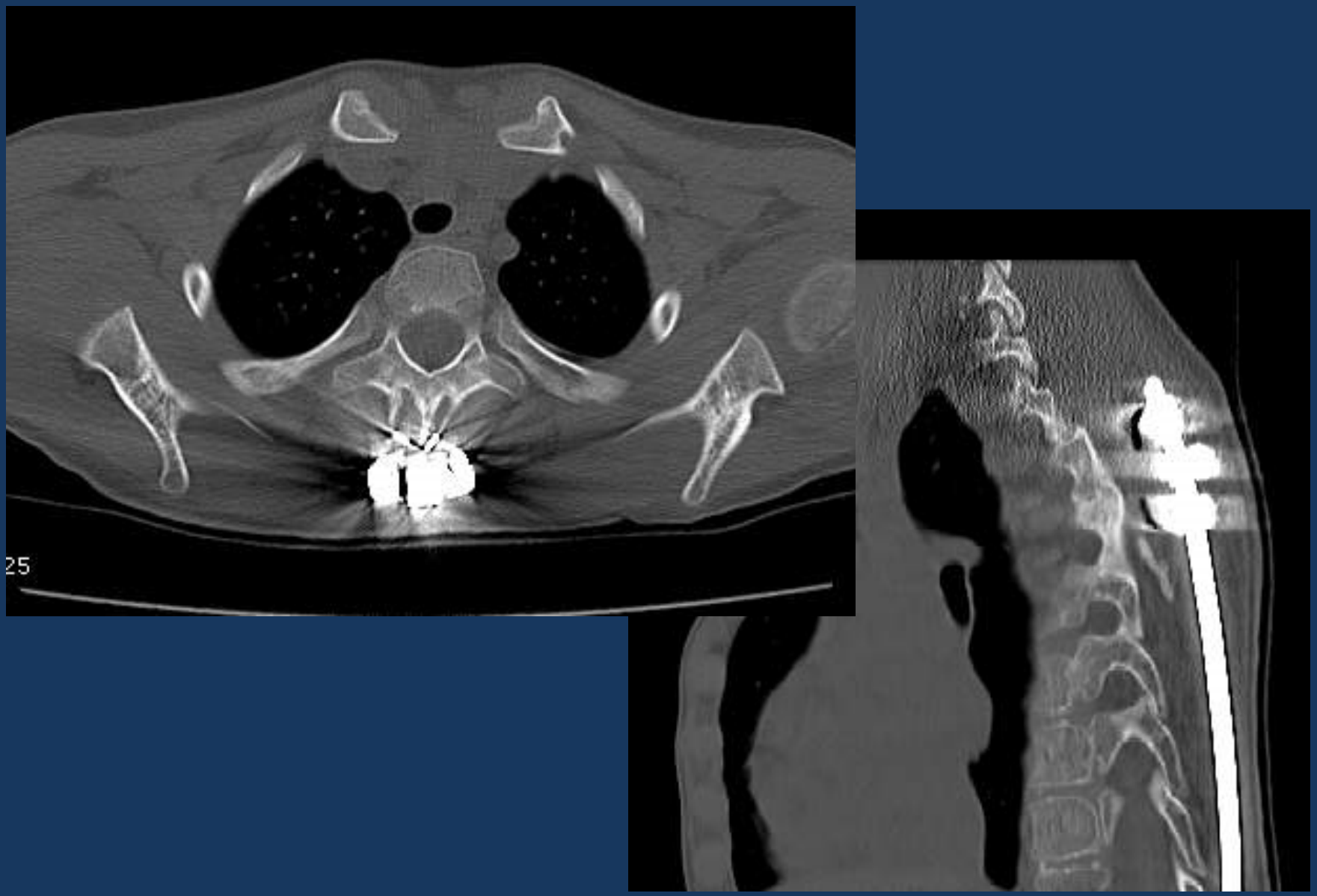
6 years FU

6 year Follow-up

Post –op Rod change

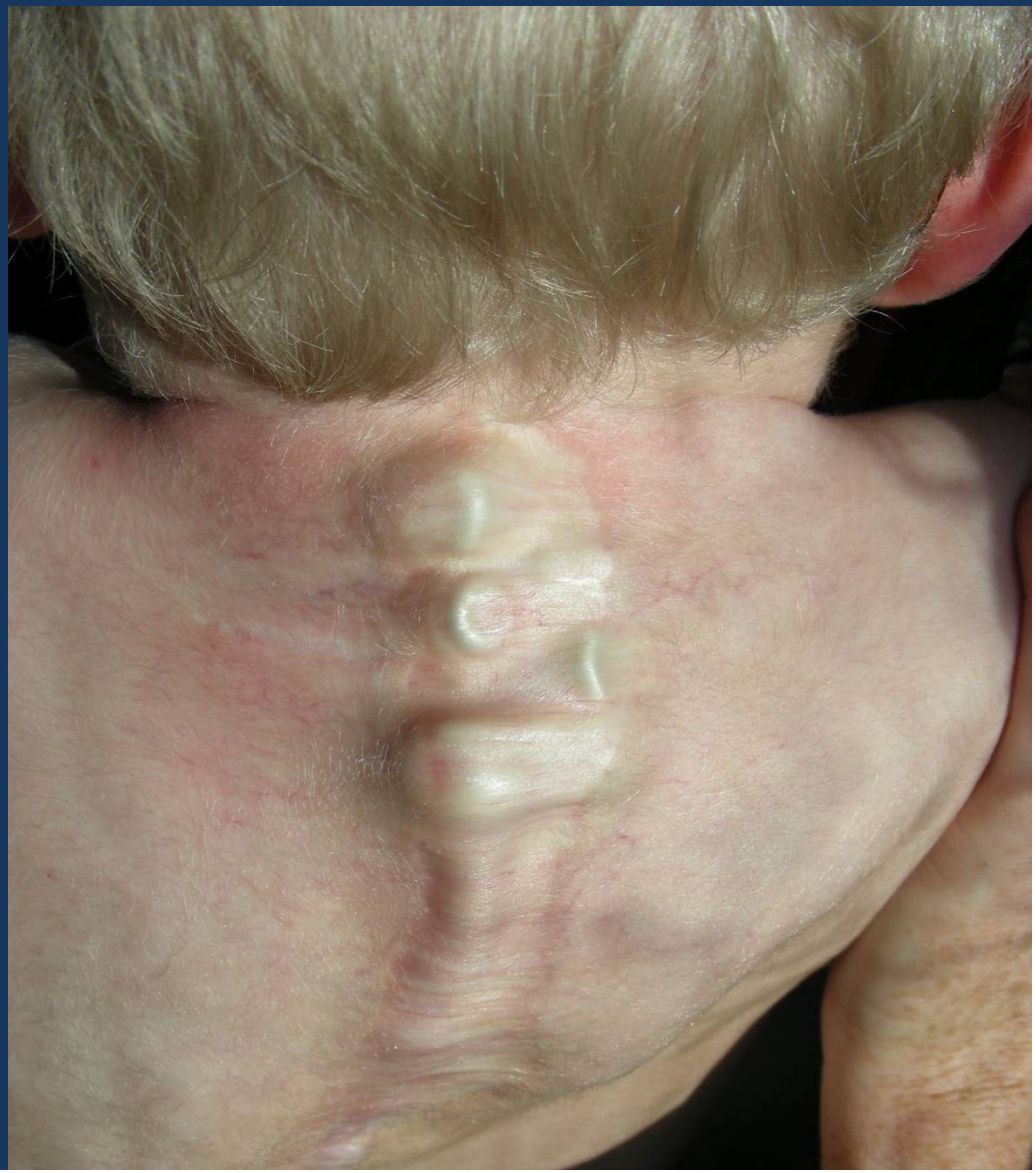


MG – Loosening of hooks


25

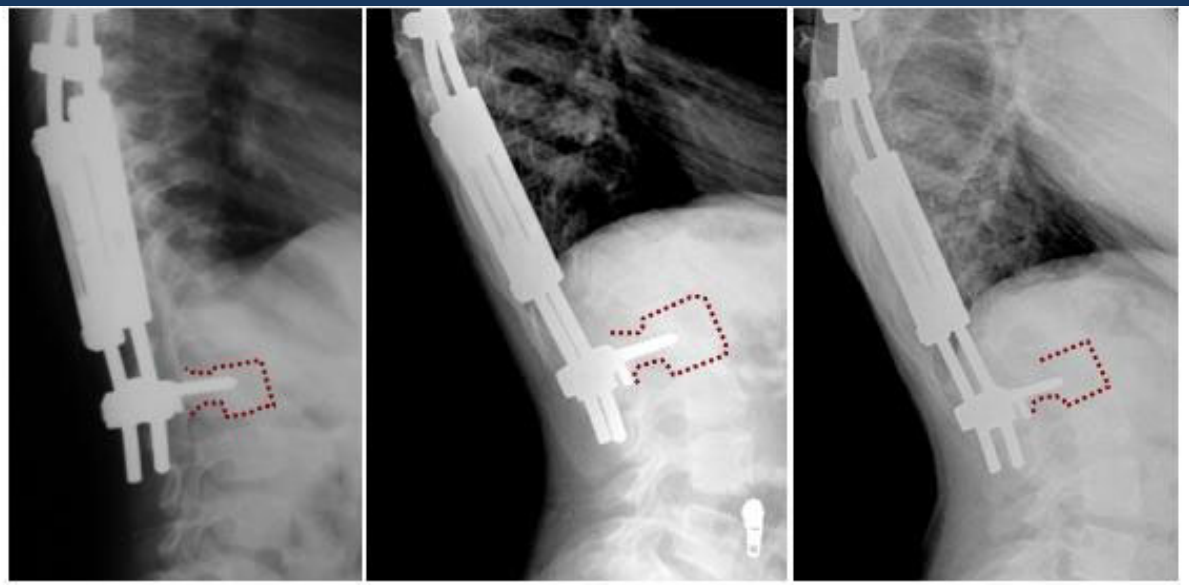
Nutritional Improvement with Growing Rods

- Significant weight gain (p=0.004)
- 49% gained weight
  - 18 percentile increase



Myung, Skaggs, 2009

Screws Affected by Growth



1997 2001

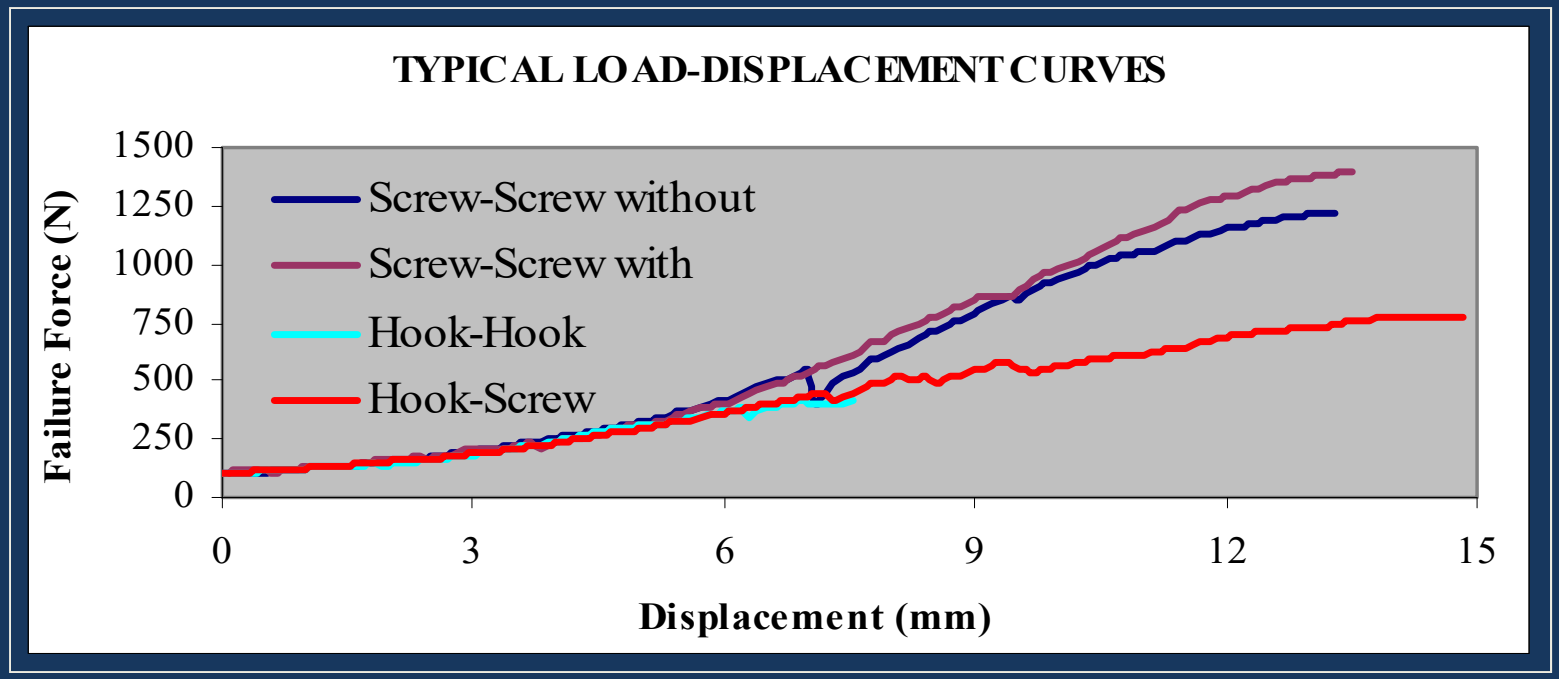
Dr El-Sebaie

Mahar, A., et al., *Biomechanical comparison of different anchors (foundations) for the pediatric dual growing rod technique*. Spine J., 2007.

RESULTS

- No structural failures of the implants
- All failures were related to bone-implant interface

RESULTS

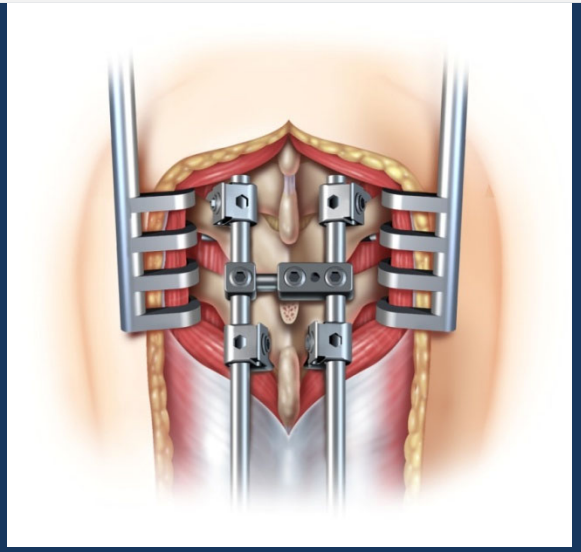

TYPICAL LOAD-DISPLACEMENT CURVES
Failure Force (N)
1500
1250
1000
750
500
250
0
0
3
6
9
12
15
Displacement (mm)
Screw-Screw without
Screw-Screw with
Hook-Hook
Hook-Screw

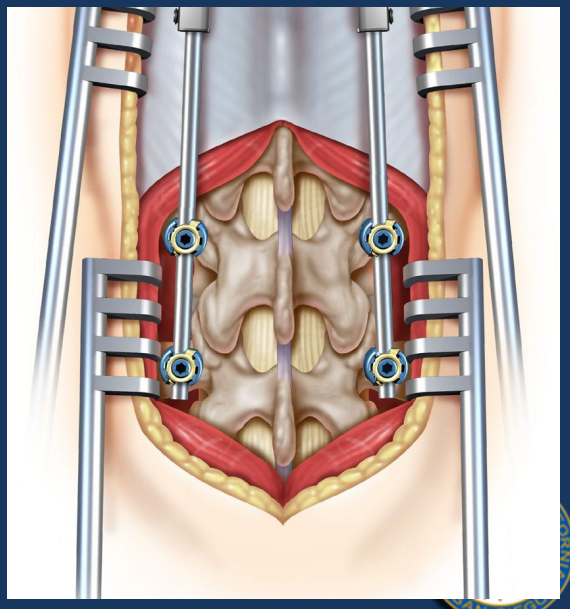
Conclusion

- Four pedicle screws construct in two adjacent vertebrae had the highest failure load
- Cross Link does not seem to enhance the fixation
- Hook constructs are stronger in lumbar vs thoracic vertebra

Methods

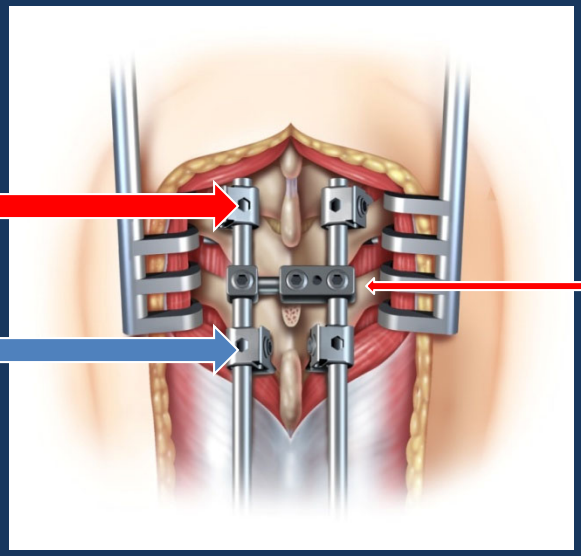
- 20 EOS patients, treated with GR
- Foundations were classified as :
  - Adequate
  - Inadequate
- Adequate foundations defined as:
  - Combination of four hooks and a cross connector
  - Four pedicle screws
- Everything else defines as inadequate



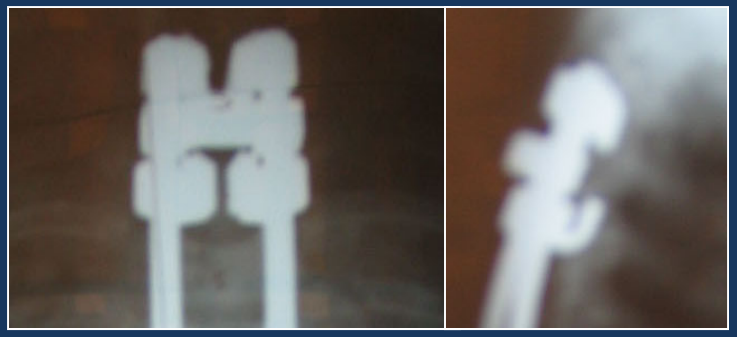


Supra-laminar

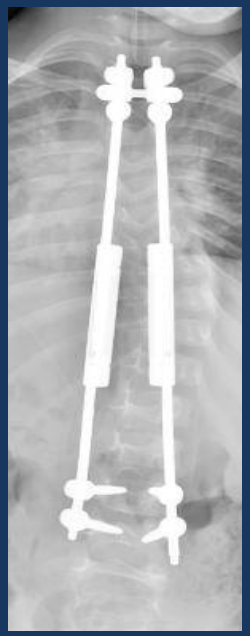
Infra-laminar



Cross link



Adequate or Classic



Inadequate

Results

- Over all complication rate
  - Screws 12.3% (8/65)
  - Hooks 5.3% (7/131)
  - Mean time to complication : 20.8 months for screws and 17.7 months for hooks
- Complications in adequate group
  - Screws 2.7% (1/37)
  - Hooks 3% (3/99)
- Complications in inadequate foundations
  - Screws 25% (7/28)
  - Hooks 12.5% (4/32)

Biomechanical Evaluation of 4 Different Foundation Constructs Commonly Used in Growing Spine Surgery: Are Rib Anchors Comparable to Spine Anchors?

Behrooz A. Akbarnia, MD
Burt Yaszay, MD
Muharrem Yazici, MD
Nima Kabirian, MD
Kevin R. Strauss, ME
Diana Glaser, PhD

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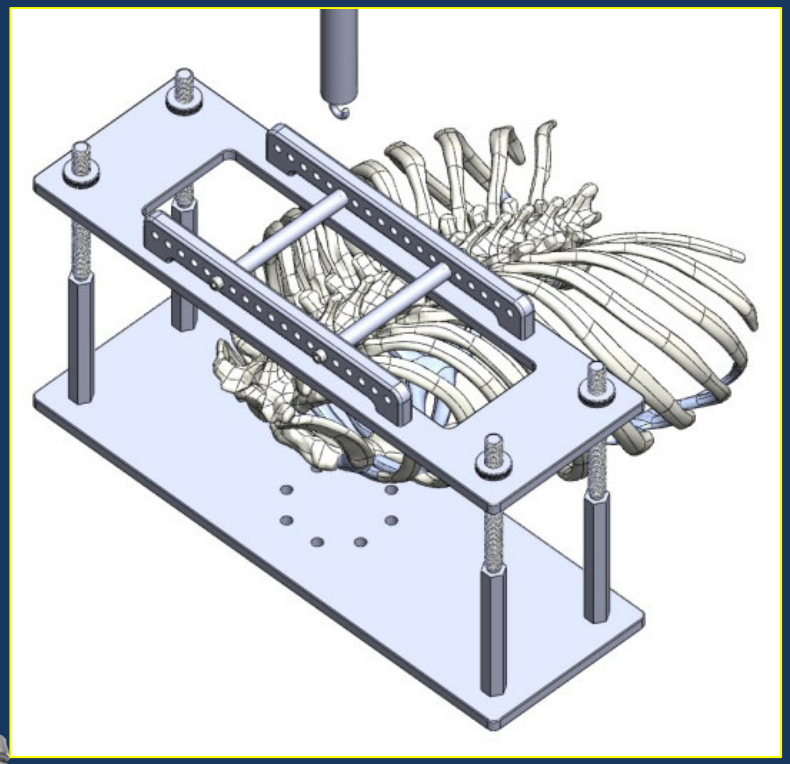
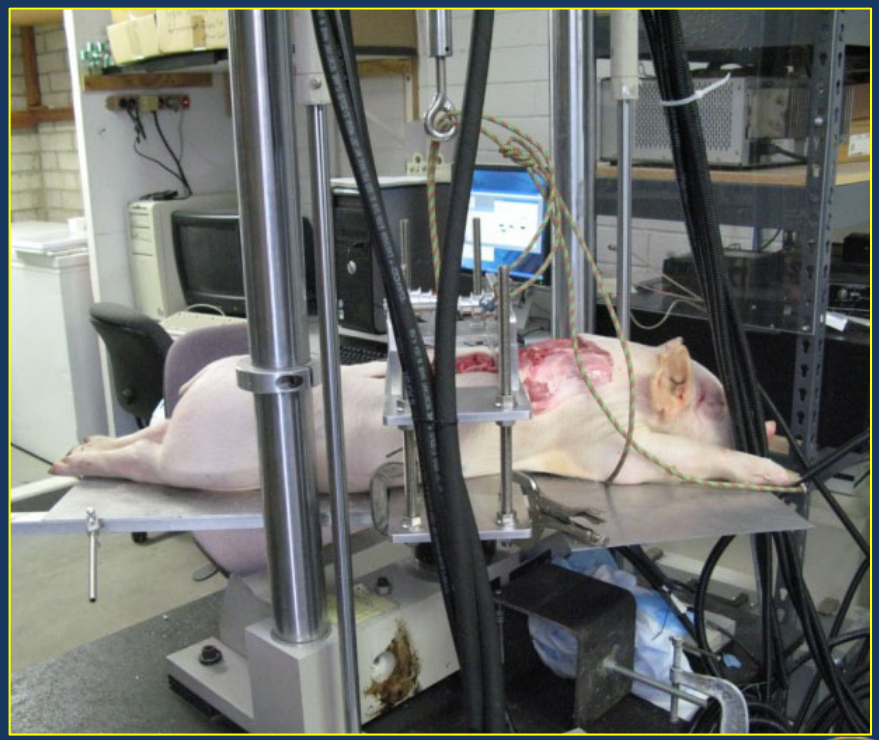
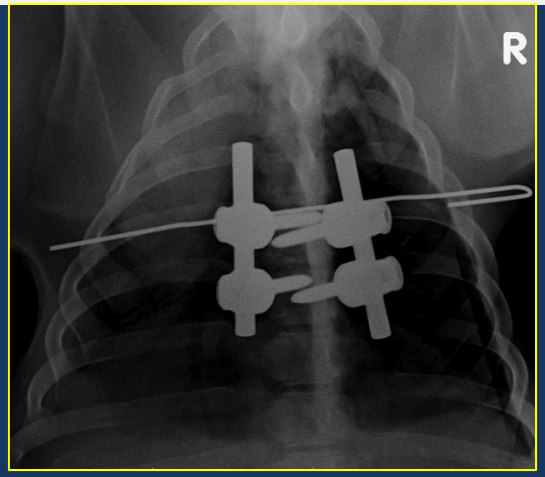
Methods & Materials

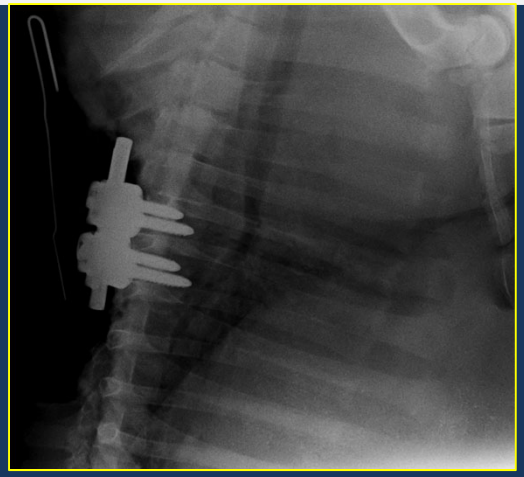
- A unique fixture was designed to brace the specimen and provide a counter-force.



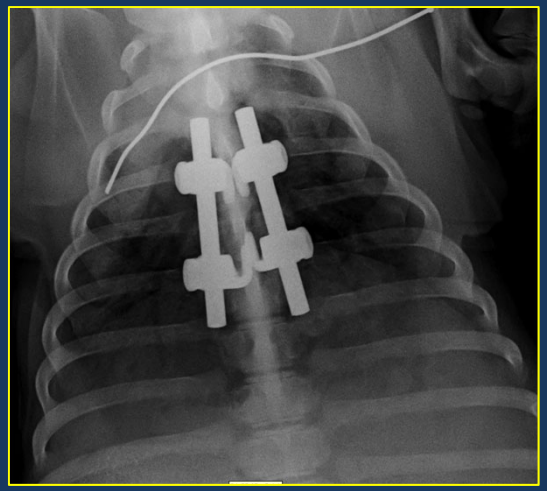


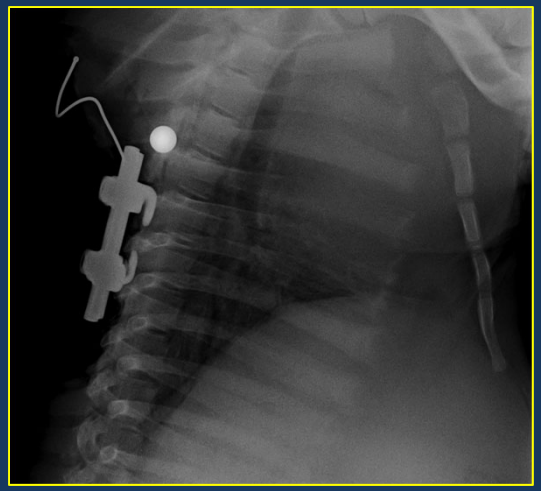
Pedicle Screw-Screw (SS)



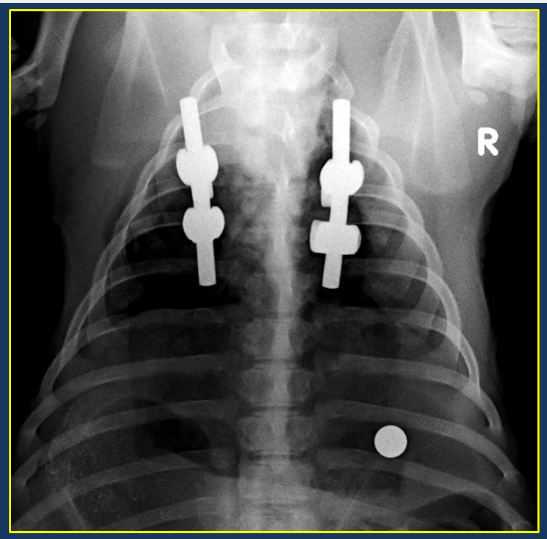


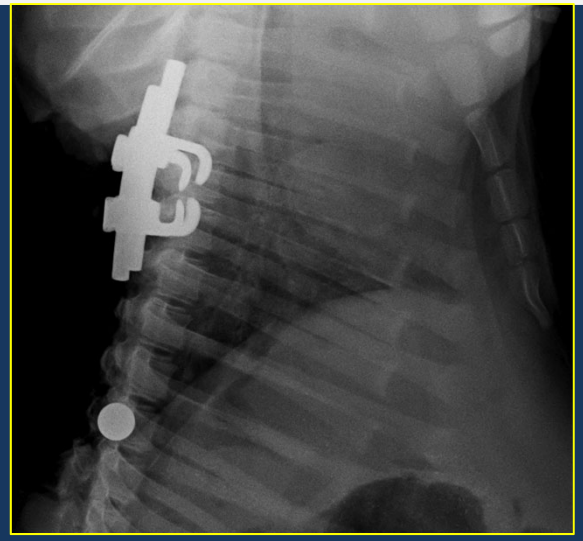
Laminar Hook-Hook (HH)



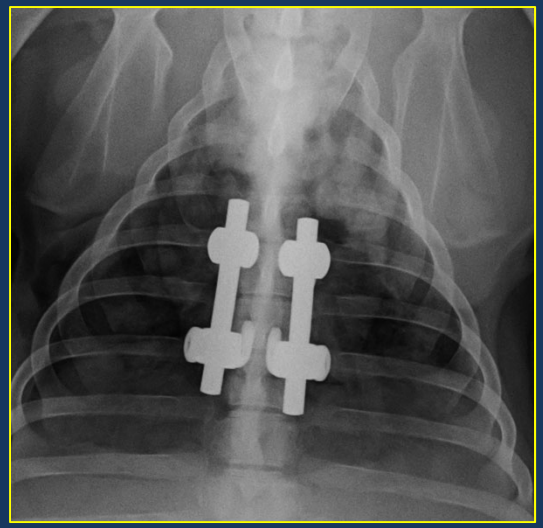


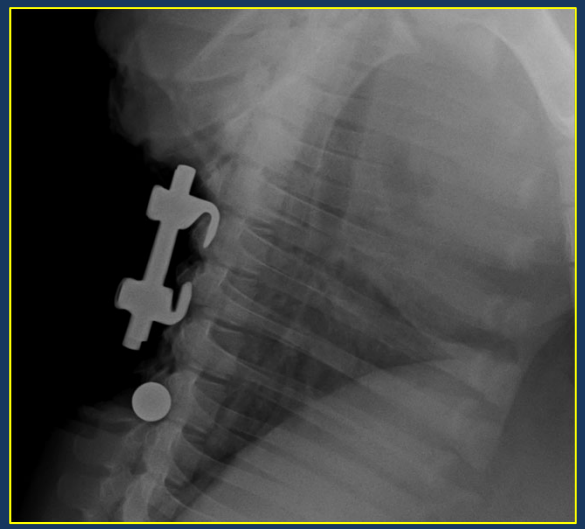
Rib-Rib Hook (RR)





Transverse Process-Laminar Hook (TPL)





Results

- All specimens eventually failed at the bone-anchor interface. No failures were observed in the instrumentation utilized.

Construct Type	Maximum load for failure (Mean & Standard Deviation)
(Screw-Screw) SS	349 ± 89 N
(Laminar Hook-Hook) HH	283 ± 48 N
(Rib Hook-Hook) RR	429 ± 133 N
(Transverse Process-Laminar Hook-Hook) TPL	236 ± 60 N

- Young's Modulus was calculated for each construct type and no statistically significant difference was determined.

Rib to Spine

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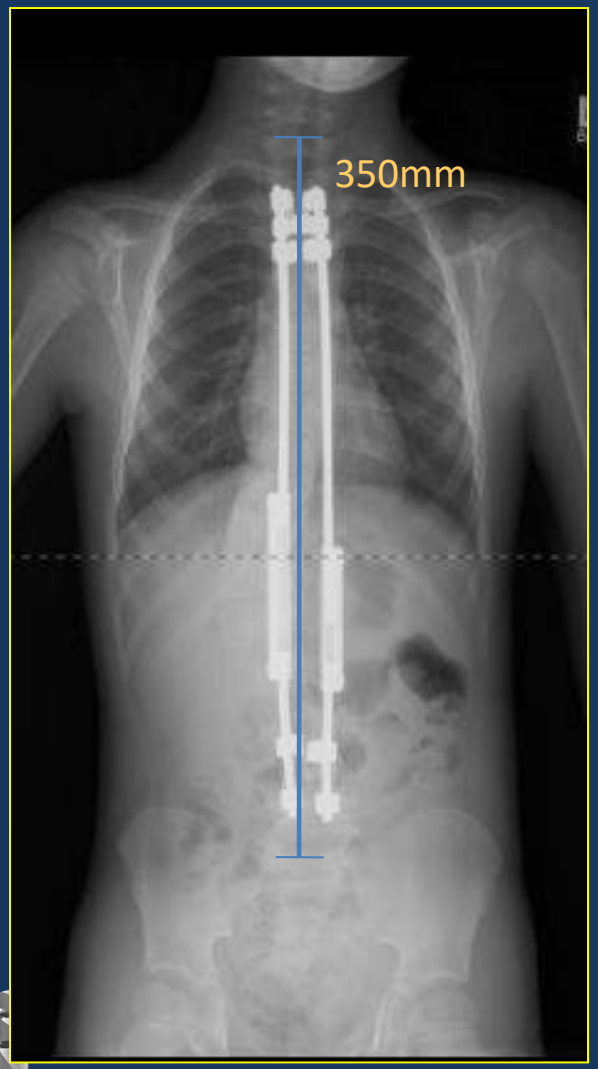
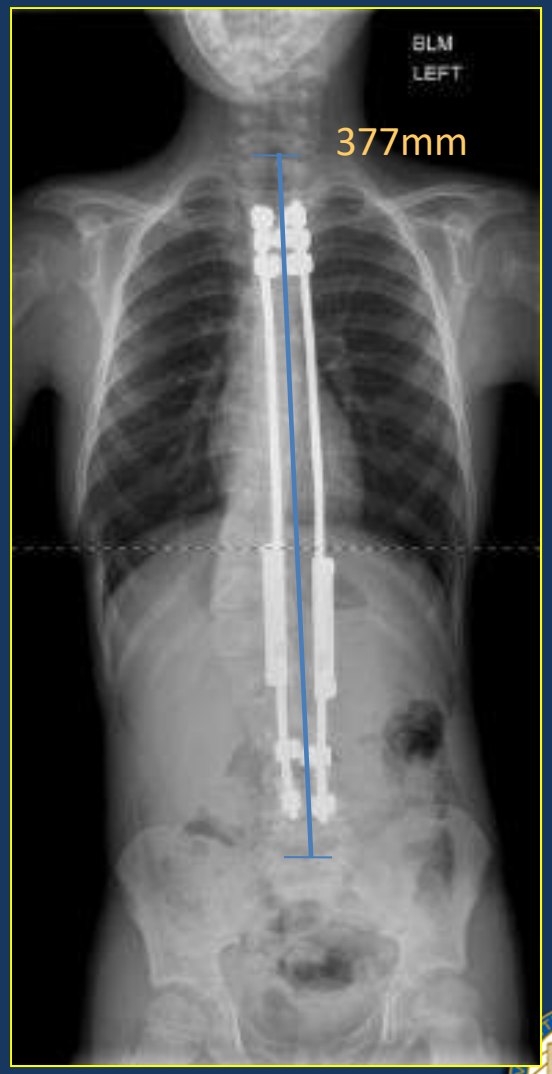
- Lengthening and exchange
- Post-op care



27 mm of lengthening

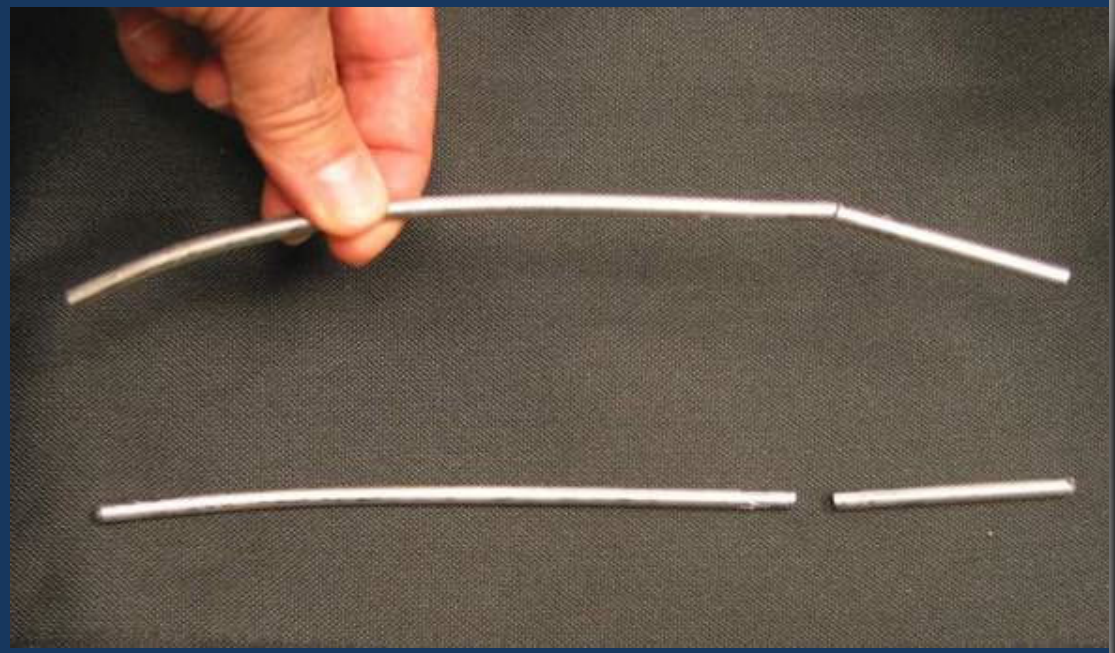


Pre-lengthening

Post-lengthening

Rod Replacement

- Both rods were weak or broken at same level



How to Avoid and how to Treat Complications

- Patient selection (age, diagnosis…)
- Correct surgical procedure (levels, sagittal alignment, techniques of exposure and instrumentation
- Early detection of potential complications
- Treatment of complication (long term goal)
- Minimize number of surgeries

Thank you