Complications of Anchors in the Growing Rod Technique

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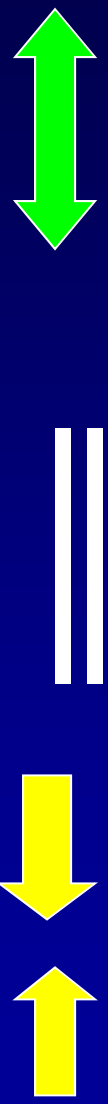
Disclosures

Author	Relationships Disclosed
Behrooz A. Akbarnia	DePuy Spine (a, b, e), K2M (a, b, e) Ellipse (b), Medtronic (a)

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

Classification of Growth Friendly Techniques

1. Distraction based
   - Growing Rods
   - VEPTR
   - Remote Lengthening (Phenix, Ellipse)
2. Guided Growth
   - Luque-Trolley
   - Shilla
3. Compression Based
   - Tether
   - Staple



< age 8 ?

< age 9 ?
All etiologies

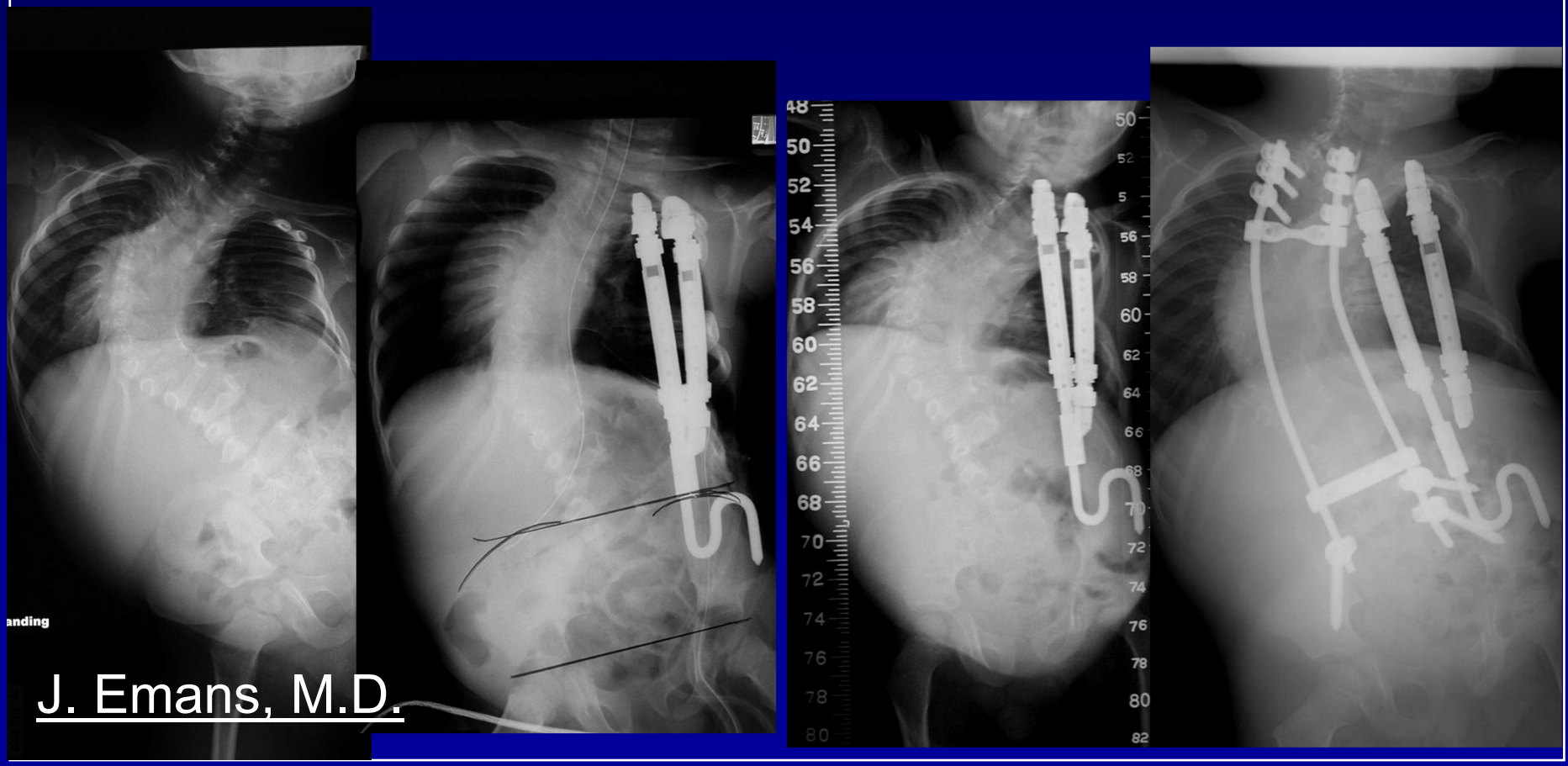
< age 9 ?
All etiologies

>age 8
Non-congenital

Complications for Distraction Based Implants

- Inherent challenges
  - No bony fusion
  - Construct is weight bearing and subject to motion for the lifetime of its use

Rib fracture at index procedure 18mo vertebral anomalies, rib fusions, VACTERL – acute loss of correction – eventual control with growing rods

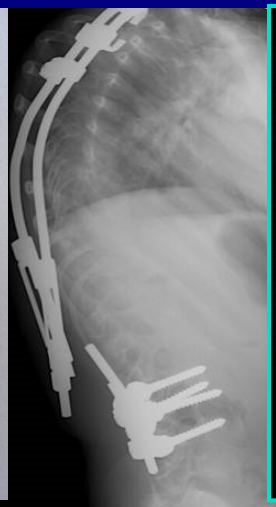


J. Emans, M.D.

Specific Implant Related Complications for Growing Rods

- Skin-related complications:
  - Superficial wound infection
  - Deep wound infection

- Implant-related complications:
  - Implant prominence
  - Rod fracture
  - Screw pull out
  - Hook dislodgement



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Complications in 910 Growing Rod Surgeries: Use of Dual Rods and Submuscular Placement of Rods Decreases Complications

Bess, Akbarnia, Thompson et al and Growing Spine Study Group

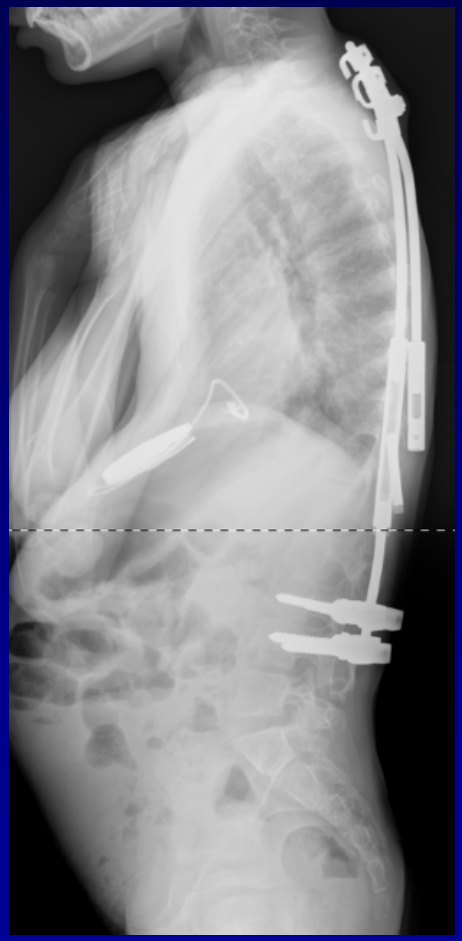
SRS 2008 and Submitted to JBJS

Demographics & Treatment Groups

- 143 patients (1987-2005)
- Avg. age =73.2 mo. (19.5-144 mo.)
- 910 GR surgeries
  - 13.3 levels (7-18)
  - 6.4 procedures/ pt (2-15)
  - 4.5 lengthening/ pt (0-13)
  - Final fusion=53 pts (37%)
- Follow up=59.4 mo. (24-166 mo.)

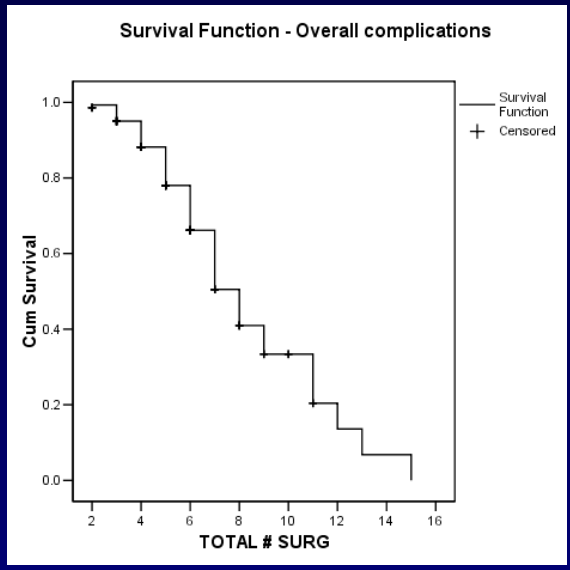
Demographics & Treatment Groups

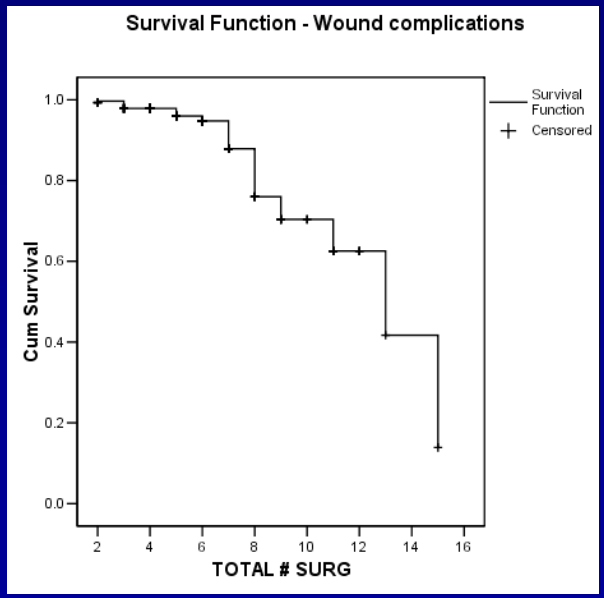
- Treatment groups
  - Construct type (NS)
    - SI; n=73
    - DU; n=70
  - Subgroups (*=p<0.05)
    - SI SQ; n=17*
    - SI MU; n=55
    - DU SQ; n=35
    - DU MU; n=35



Results

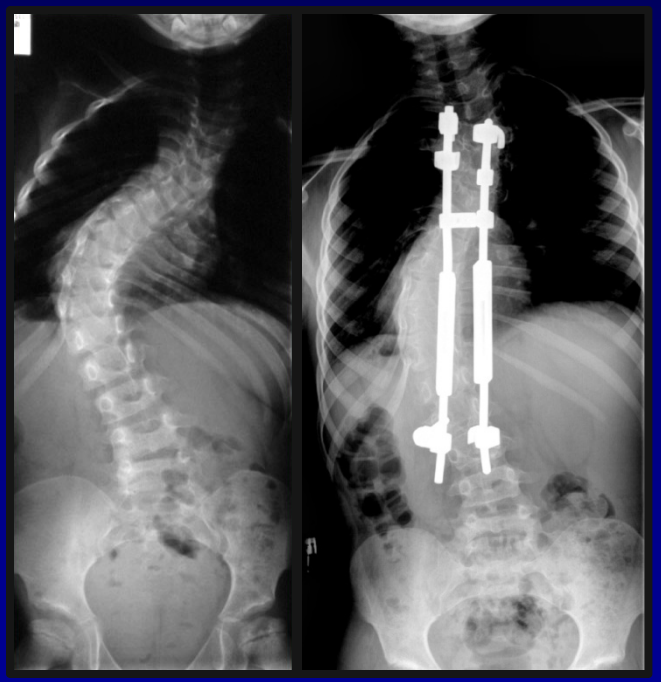
- Kaplan-Meier Survival Analysis
- Total complications vs. Procedures
  - 50% survivorship at 7 surgeries
- Wound Complications vs. Procedures
  - 90% survivorship at 7 surgeries
  - 40% survivorship at 13 surgeries
- Odds Ratio: Complication vs. Procedure
  - 24% increased complication risk each additional procedure
  - (Odds Ratio=1.24, 95% Confidence Interval: 1.07, 1.44, p=0.005)
- Odds Ratio: Complication vs. Age
  - 13% decrease complication risk each year increased age initial surgery
  - (Odds Ratio=0.87, 95% Confidence Interval: 0.75, 1.00, p=0.057).





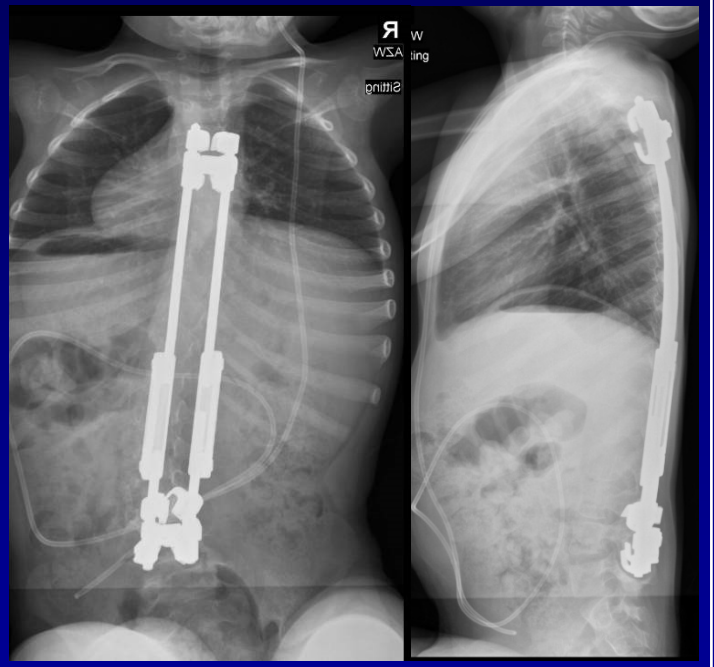
Conclusions

- Complication rates per growing rod procedure are comparable to other surgical treatments for scoliosis.
- Complications are likely due to multiple spine procedures per patient.



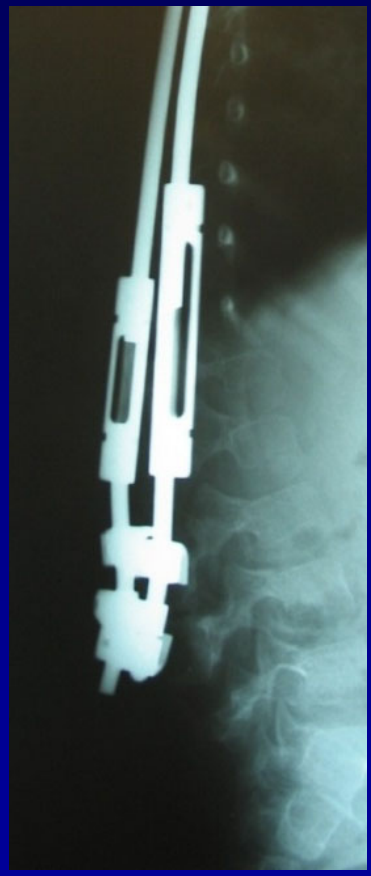
Conclusions

- Dual rod constructs reduce the number unplanned surgeries caused by implant-related complications.
- Sub-M placement decreases complication rates and wound problems, and reduces the number of unplanned surgeries.

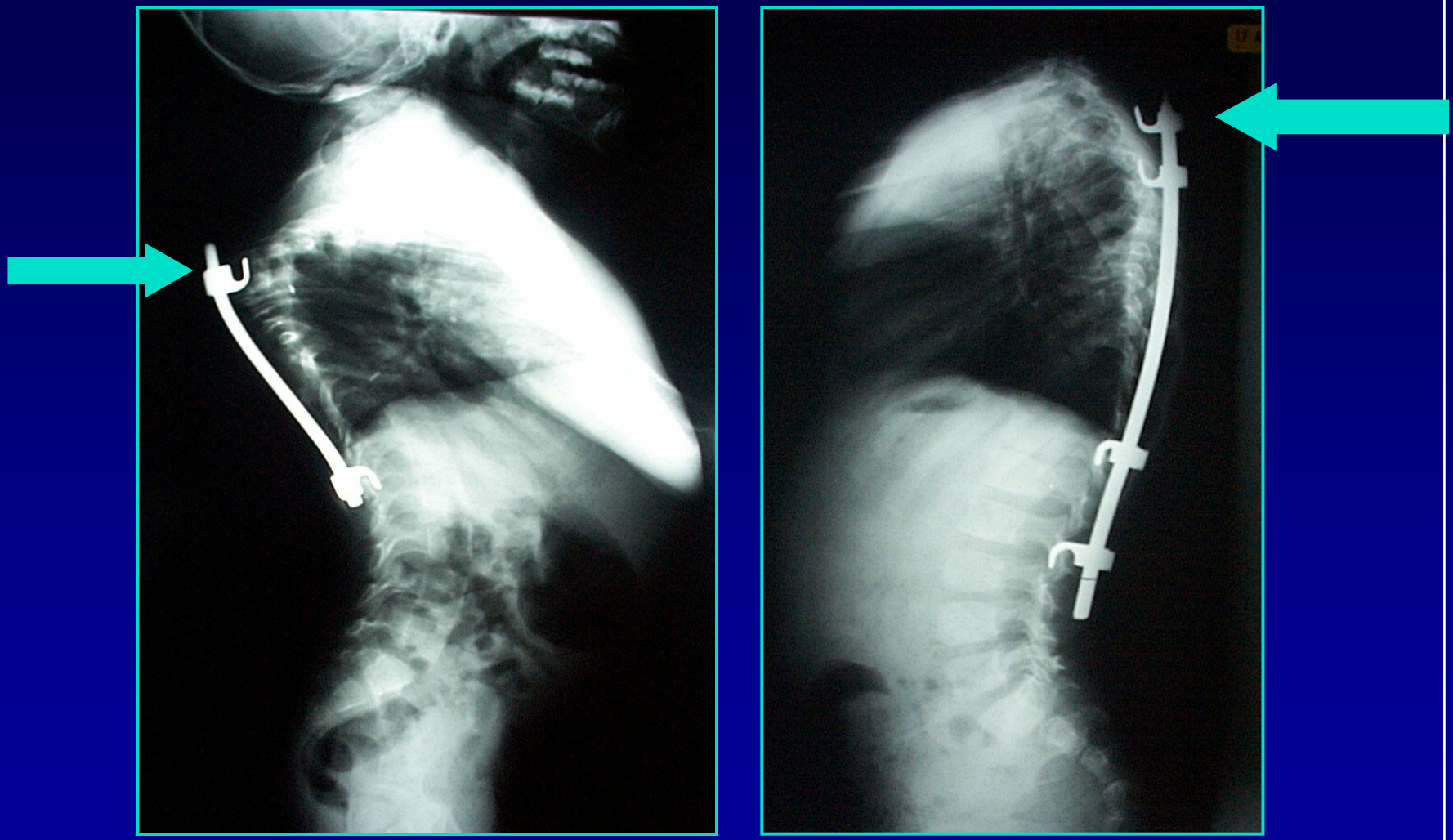


Growing Rod Implant Complications

- Anchors
  - True complication (acute)
  - Growth related

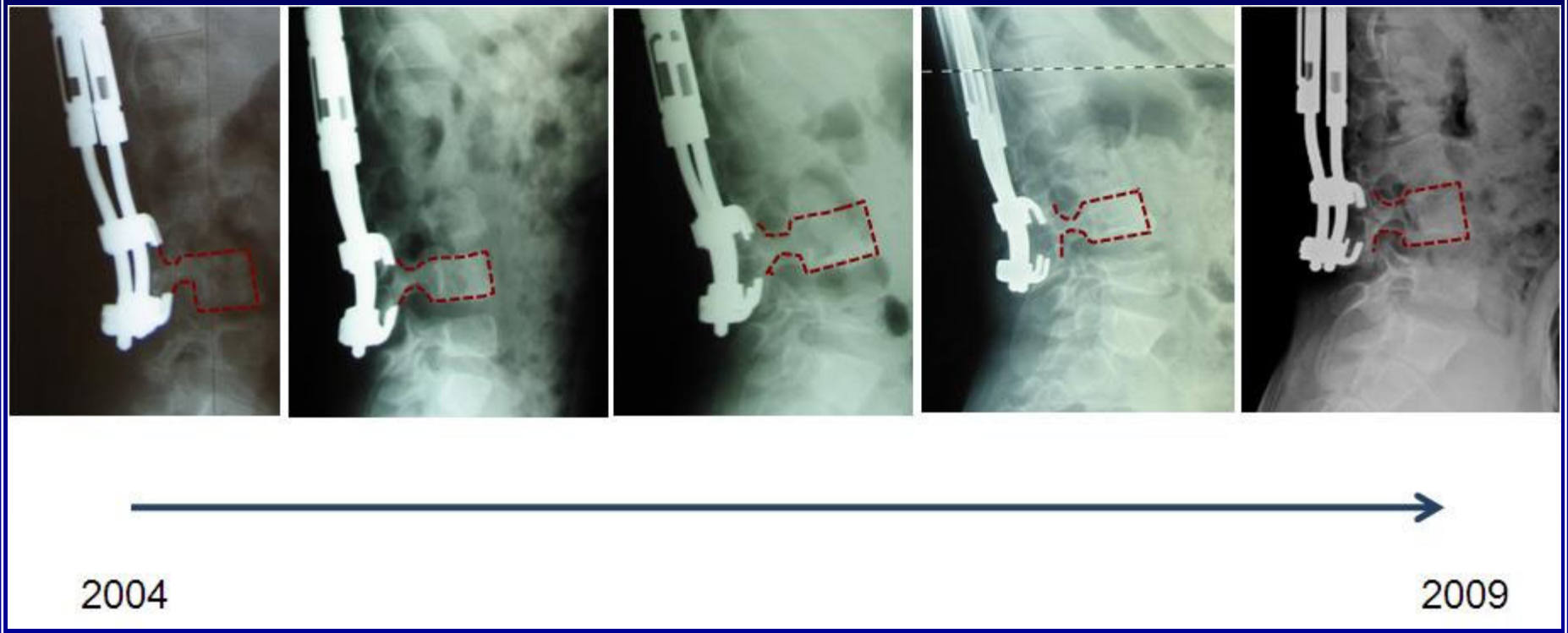


Growing Rods



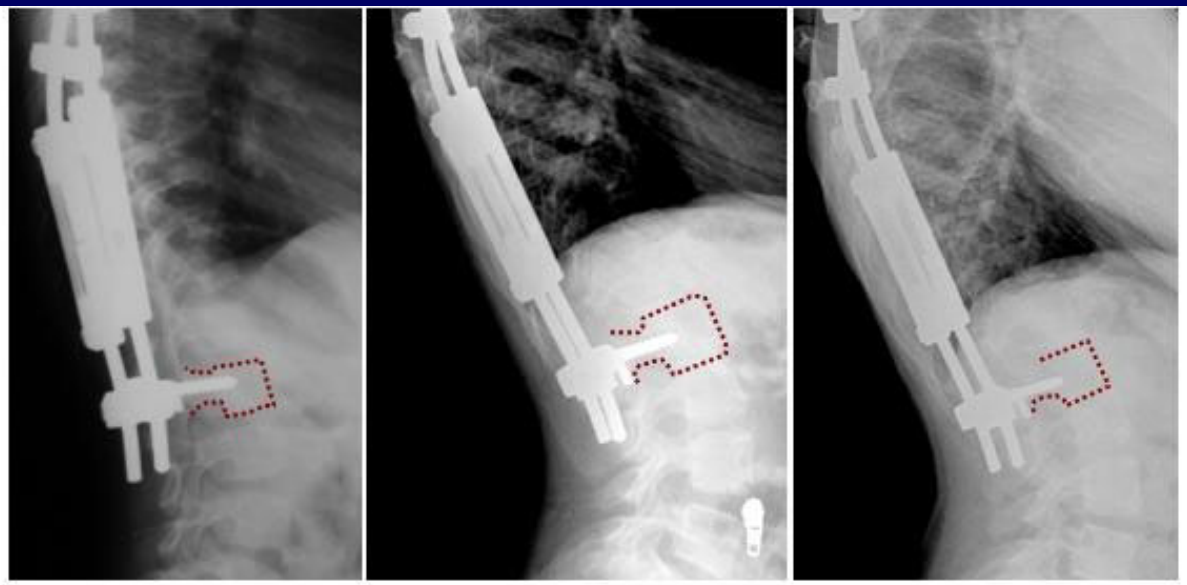
Hook Dislocation

Hooks Affected by Growth



Courtesy of H. El Sabaie, MD

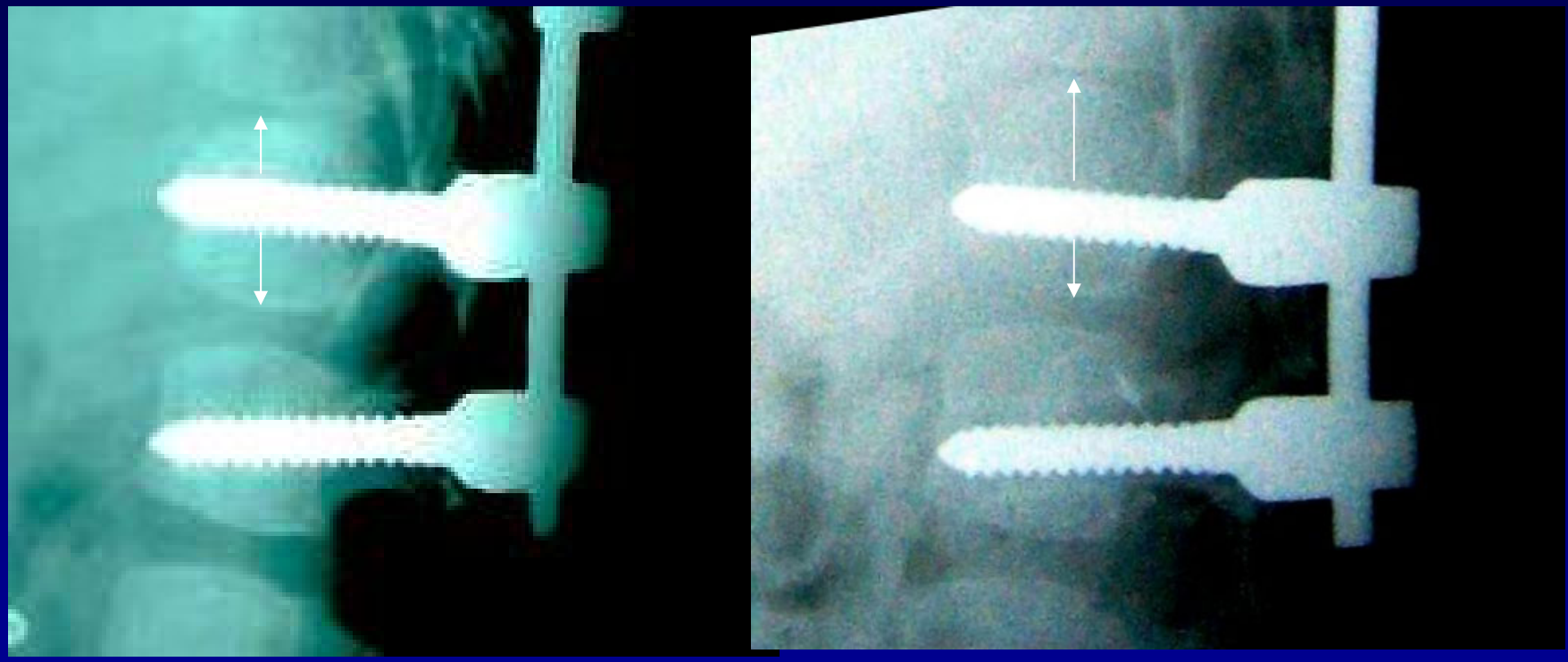
Screws Affected by Growth



1997

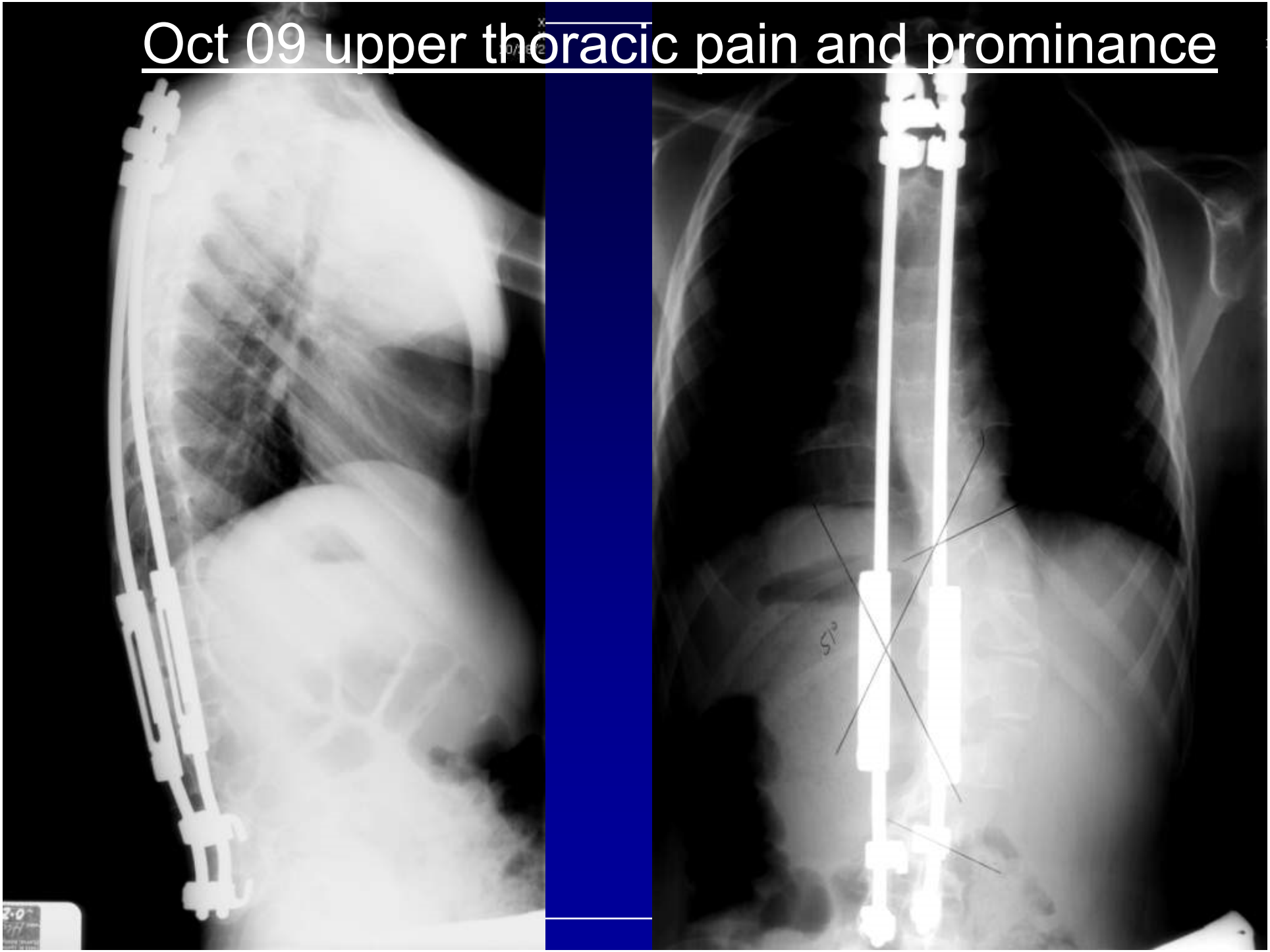
Courtesy of H. El Sebai, MD

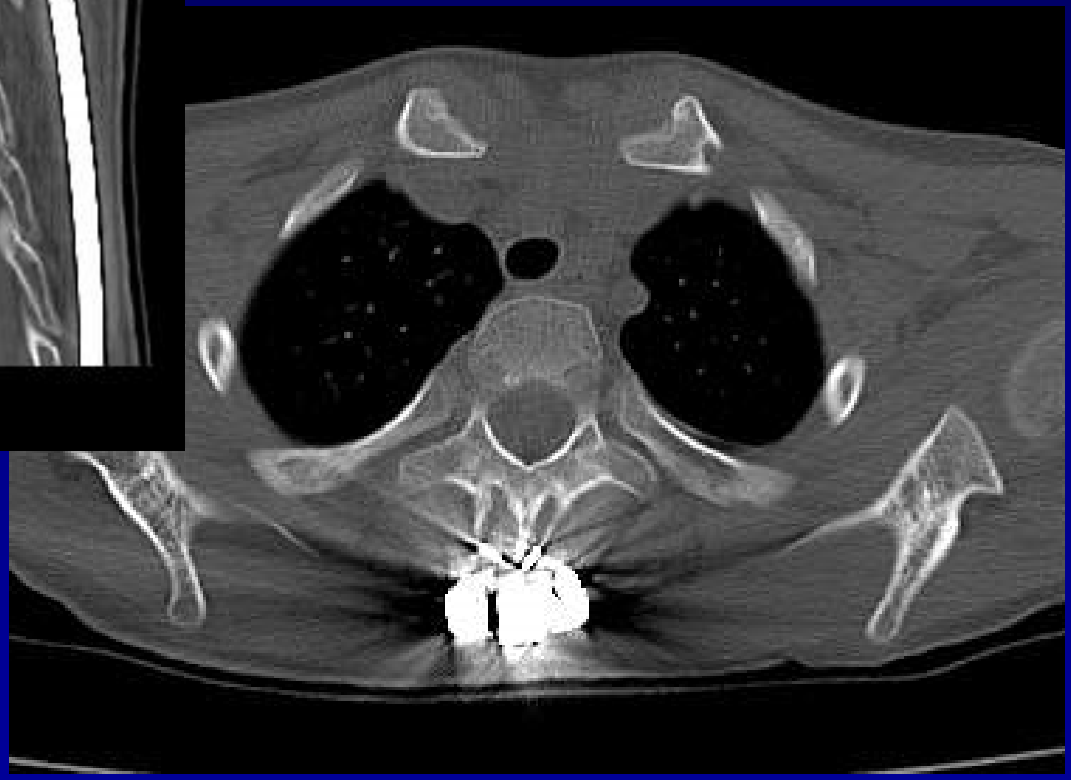
2001



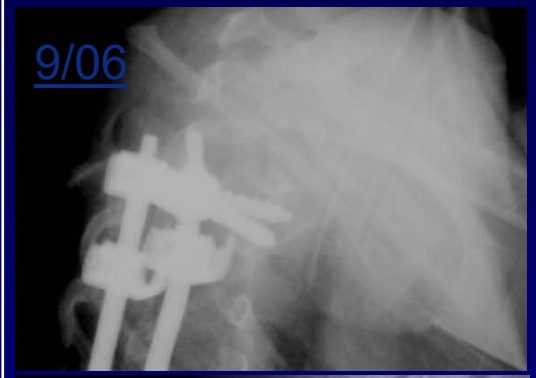
Courtesy of H. El Sabai, MD

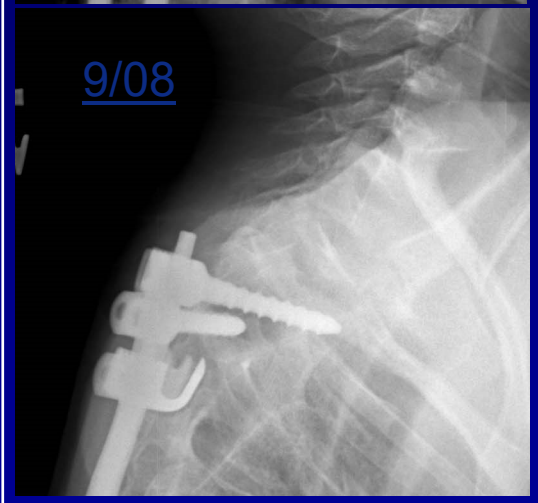
Oct 09 upper thoracic pain and prominance

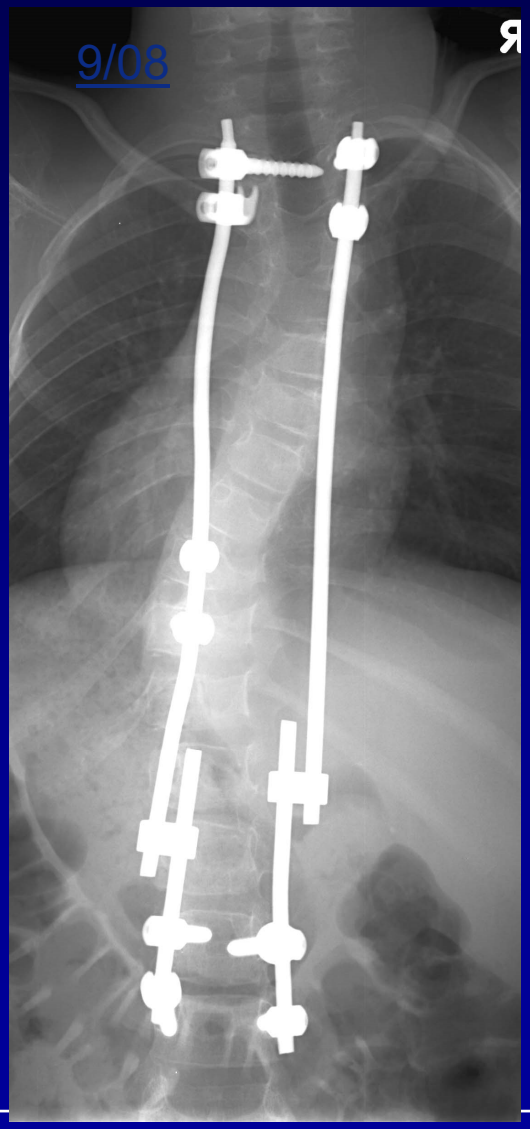


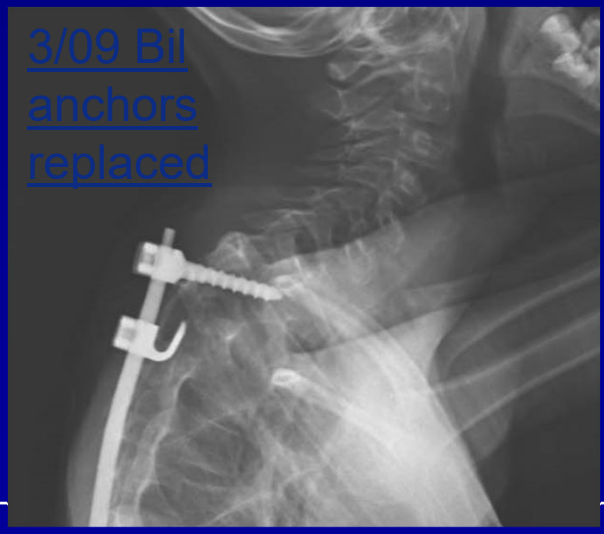


Screw Displacement



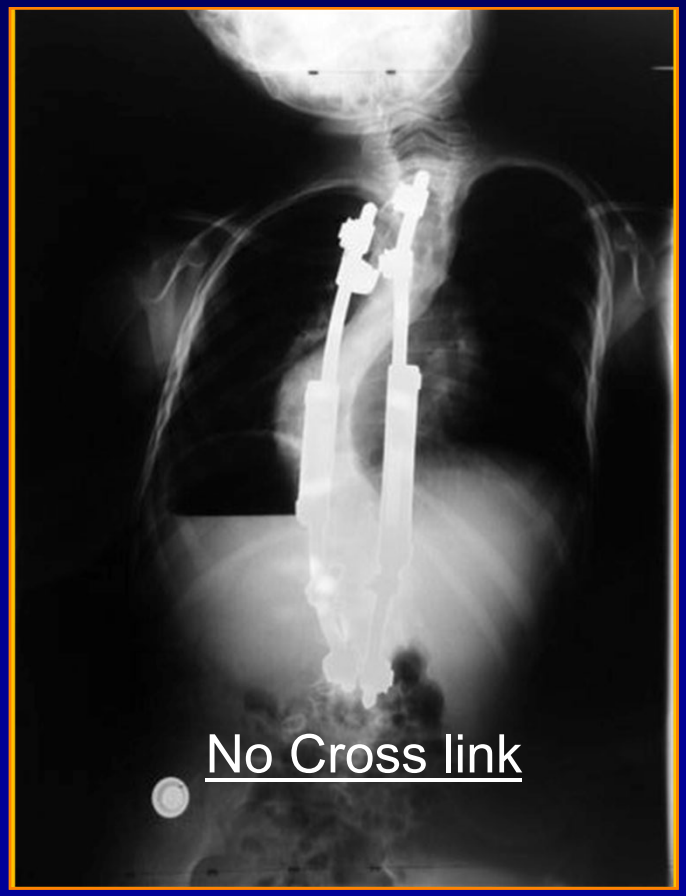


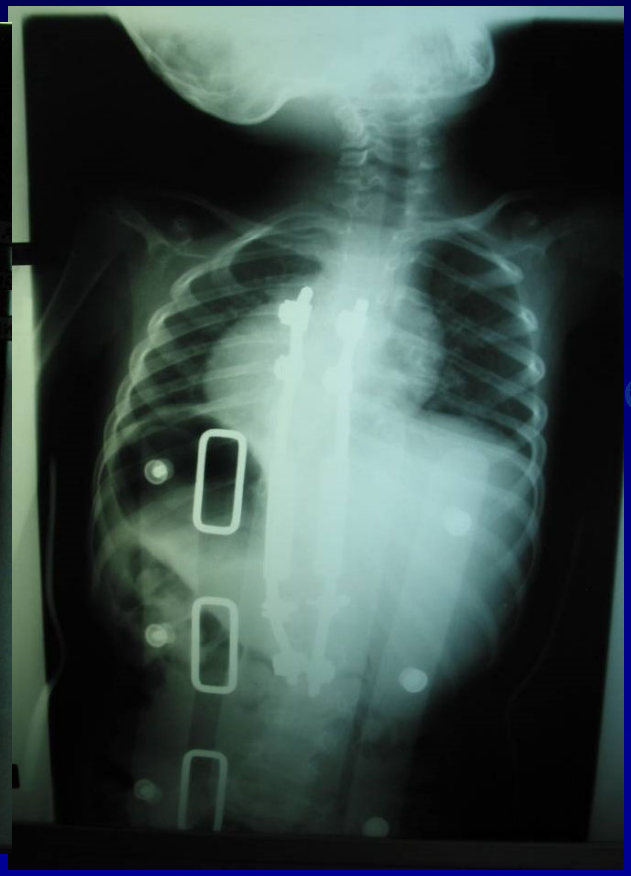


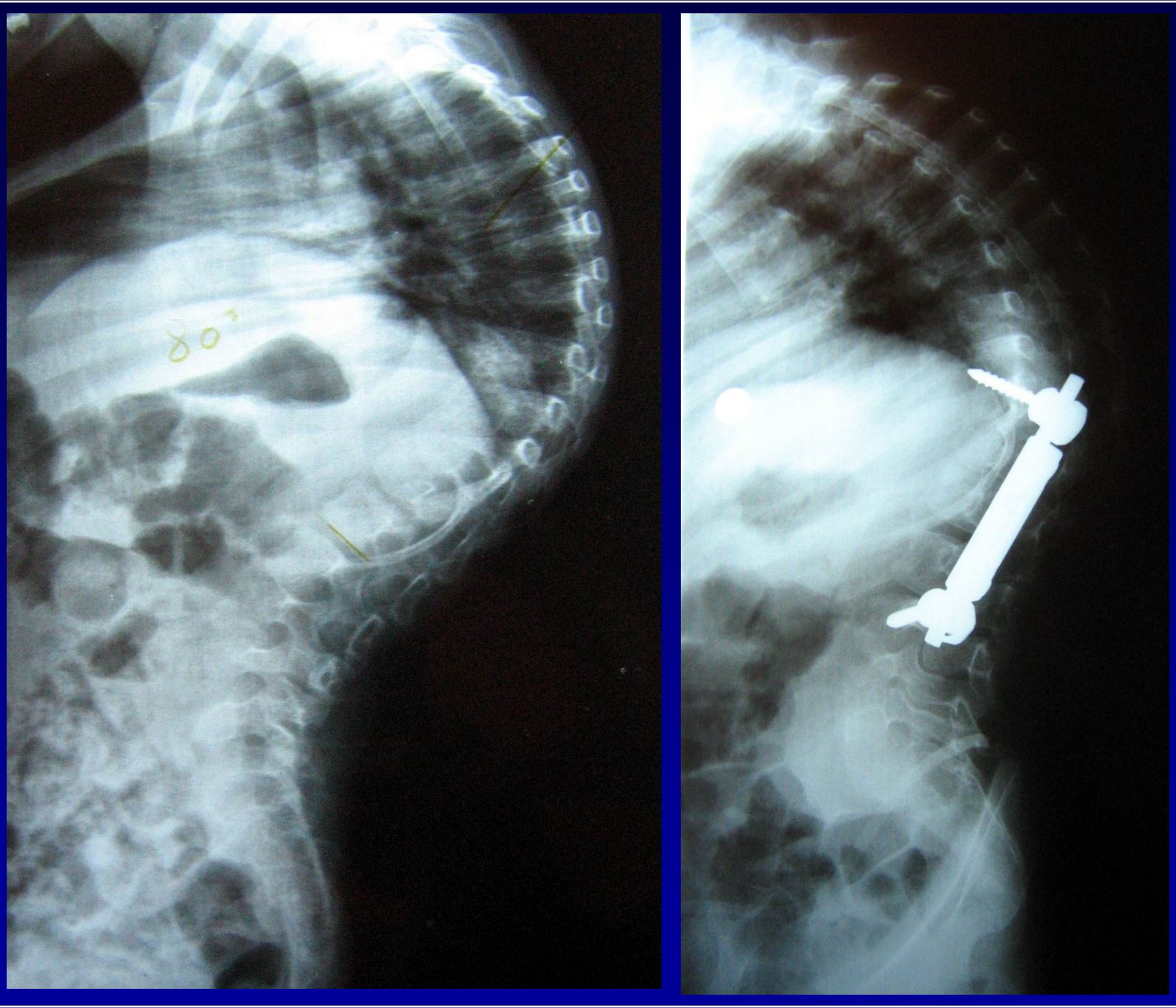


Charlie Jhonston, MD

Poor Technique



Biomechanical Comparison of Different Anchors and Foundations in the Dual Growing Rod Technique*

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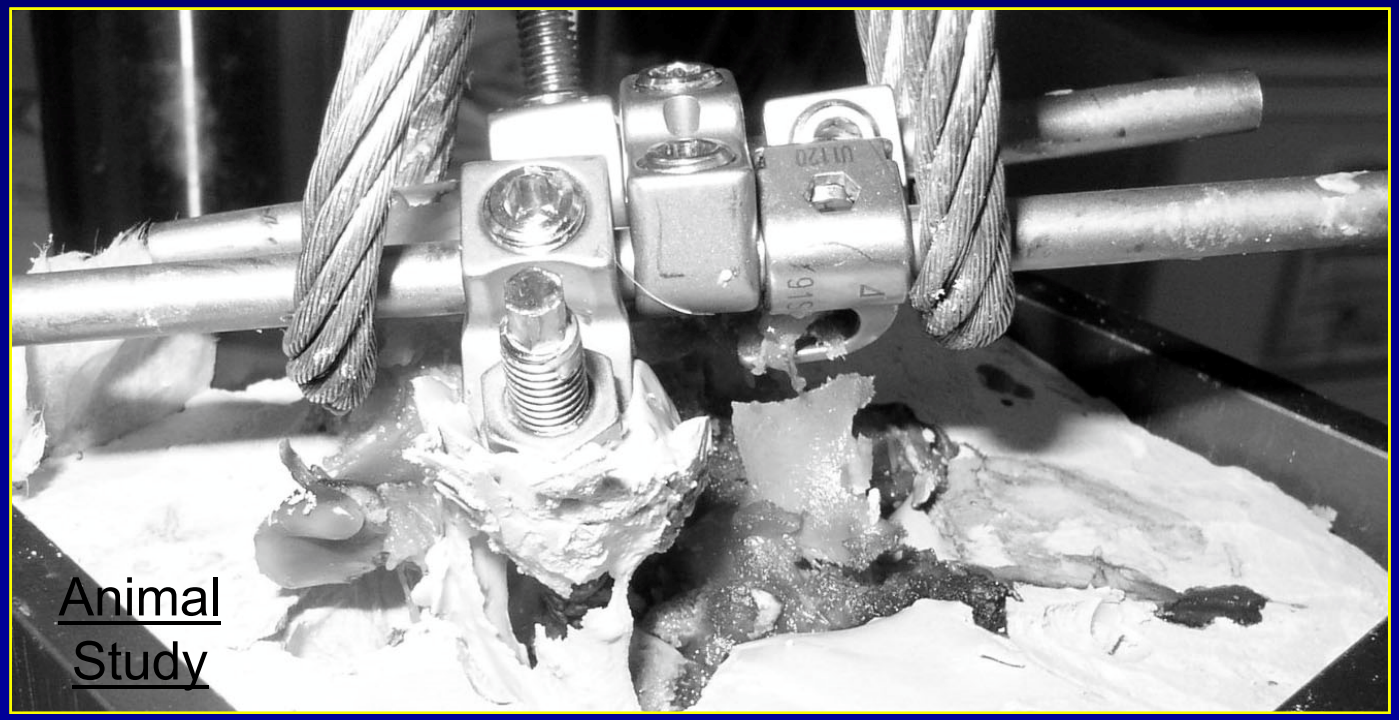
[2] Orthopaedic Biomechanics Research Center, Children's Hospital, San Diego, CA
[3] Department of Orthopaedics, University of California, San Diego

Spine Journal 2008

RESULTS

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



Animal Study

RESULTS

- Effect of level on failure biomechanics across groups
  - Upper = T3-T10
  - Lower = T11-L6

		Upper	Lower	p-value
Screw/Screw with		1274 ± 149	1515 ± 429	0.57
Screw/Screw without		1261 ± 202	1124 ± 411	0.33
Hook/Screw		810 ± 114	1151 ± 97	**0.001**
Hook/Hook		450 ± 158	792 ± 69	**0.017**
	p-value	0.0000	0.05	

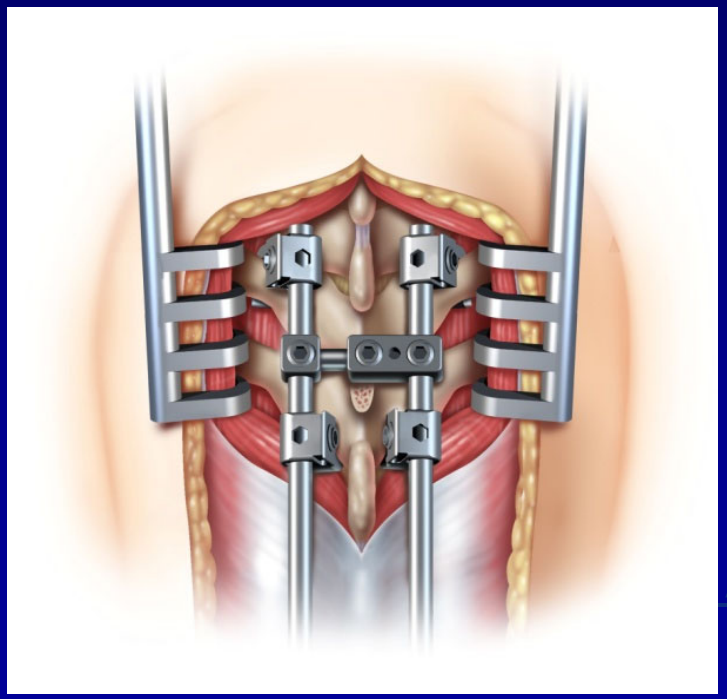
Mahar et al

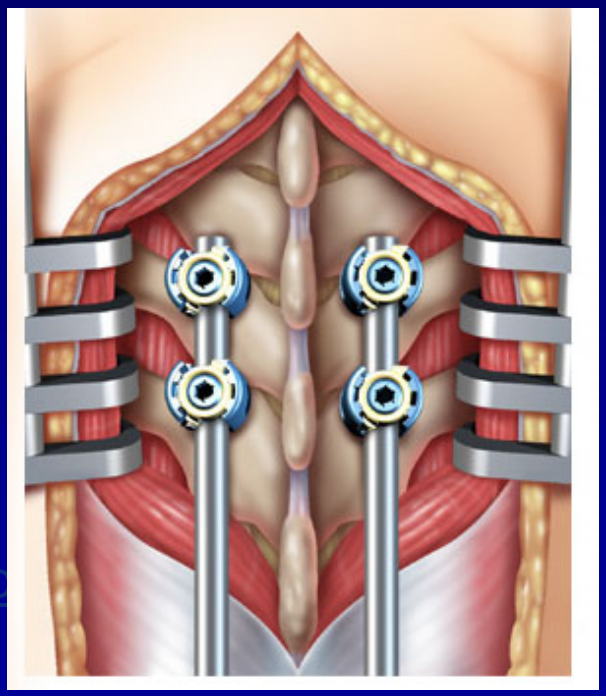
- Biomechanics study
  - hook-hook with cross-link
  - hook-screw with cross-link
  - screw-screw with or without cross-link
- A foundation composed of four pedicle screws implanted in two adjacent vertebral bodies provides the strongest construct in pullout testing

Mahar et al

- A cross-link does not seem to enhance fixation in 4-screw construct
- Hook constructs are stronger in lumbar versus thoracic laminae
- No statistically significant difference between the hook-screw and hook-hook constructs

Classical vs. Non-Classical Foundations in Growing Rod Surgery

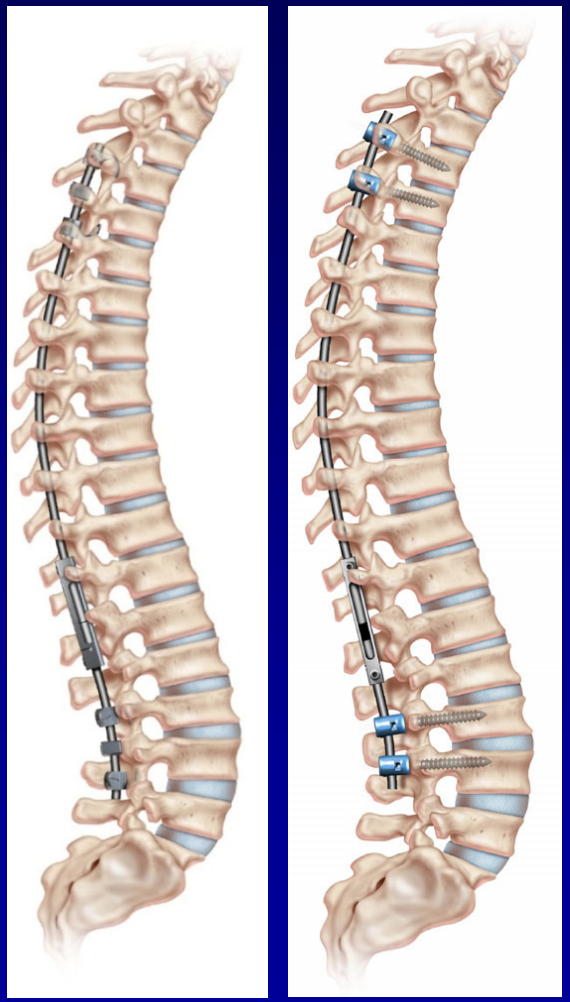




Akbarnia, Pc

Study Questions

- What anchors to use ?
- What is the best configuration for upper and lower constructs?
- What are the complication rates?



Pilot Study

- Retrospective review of 16 patients, 2 yrs FU, Dual GR
- Type of anchors, configuration of anchors (foundations) and revision surgeries were recorded
- Group A (Classic foundations)
  - minimum criteria: i) combination of at least 4 hooks (only supra-laminar hooks at upper vertebra) in 2 or 3 levels and one cross connector or ii) at least 4 screws in 2 or 3 adjacent levels
- Group B (Non-Classic foundations)
  - All other foundations were defined as non-classic

Results

- Mean age at initial surgery 74 months (19-173)
- At initial surgery 104 hooks, 20 screws and 4 wires inserted
- There were 20 foundations in group A and 12 in group B.
- Anchors were in place for average of 47.3 months

Results

- Five foundations (three in group A) were revised due to three hook pull-outs, 1 screw loosening and 1 implant prominence, with only one upper foundation failure.
- 31% of patients had complications requiring revision of anchors.

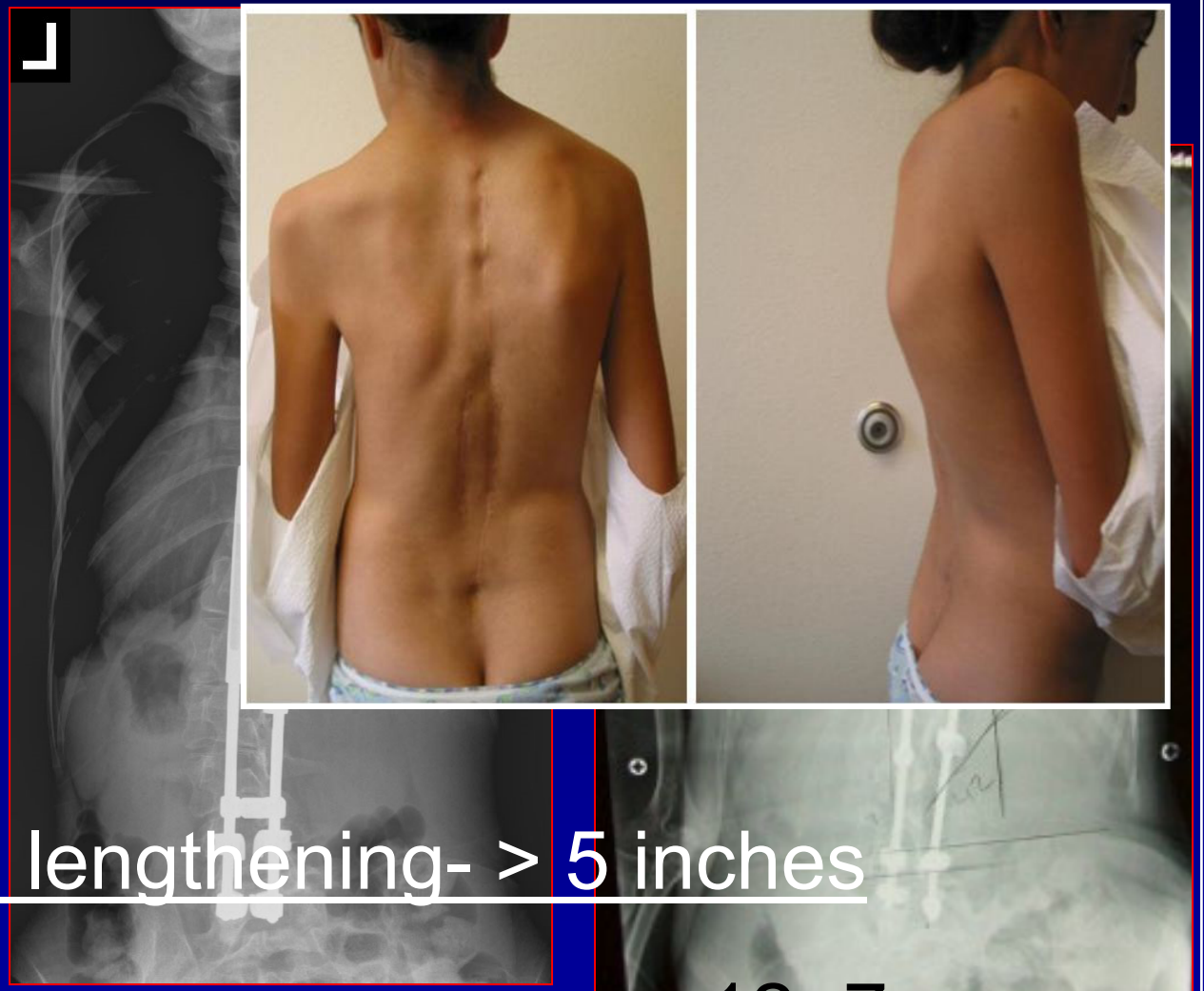
Results

- Complication rate in hooks and screws was 5% (6/119) and 4.65% (2/43), respectively.
- Mean time from initial surgery to complication was 45 months for hooks and 41.5 months for screws.
- Three out of six hook failures and both screw complications occurred in lower foundations.
- At time of final follow up, seven of the 16 patients had undergone final fusion.

Conclusions

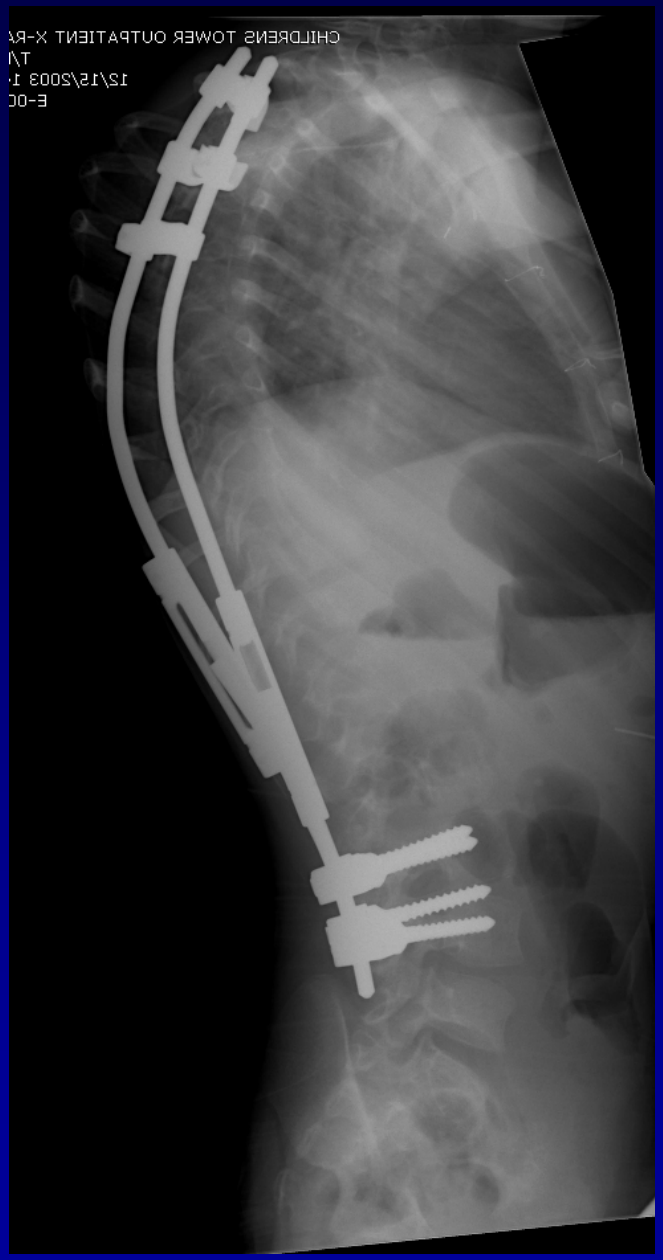
- There is no significant difference in complication rates between screws and hooks in this series
- Assortment of anchors in foundations does not seem to be a principal factor
- Complications appear to be more common in lower foundations.
- **An improved study involving a larger sample of patients is required**

Case Example #1 (Marfan's)

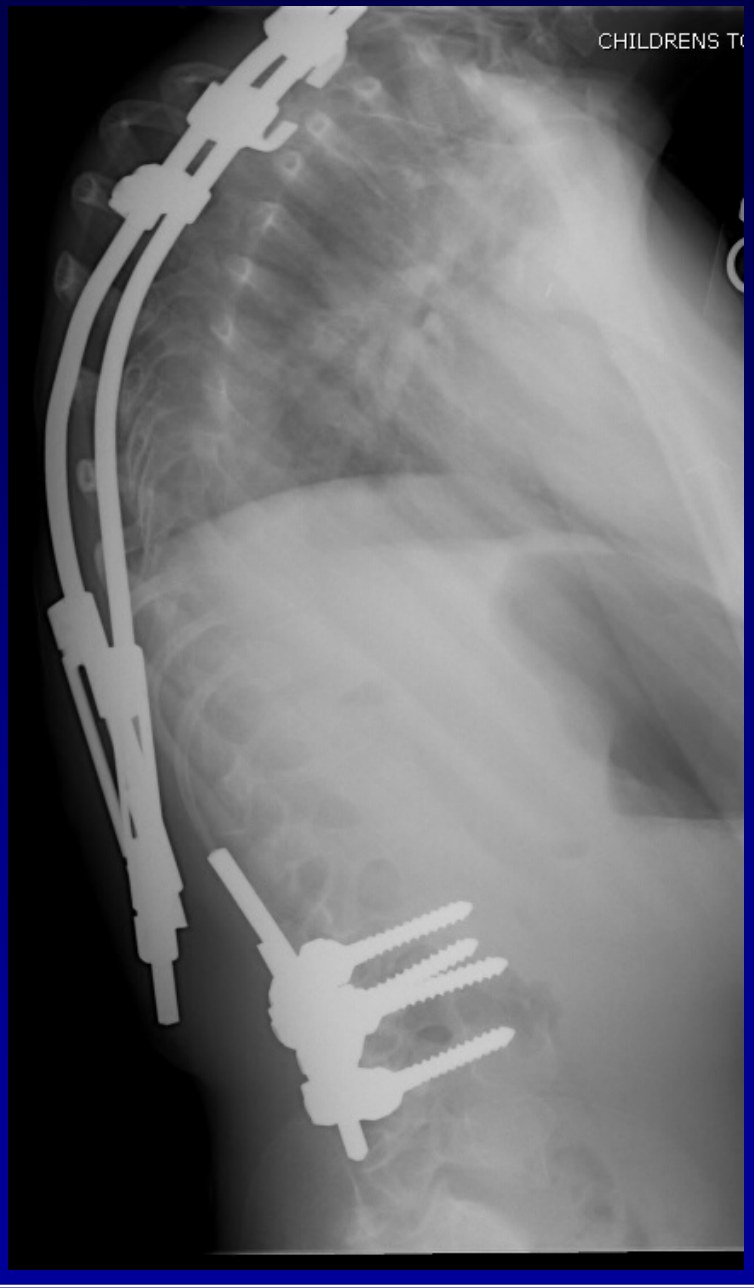


12 lengthening- > 5 inches

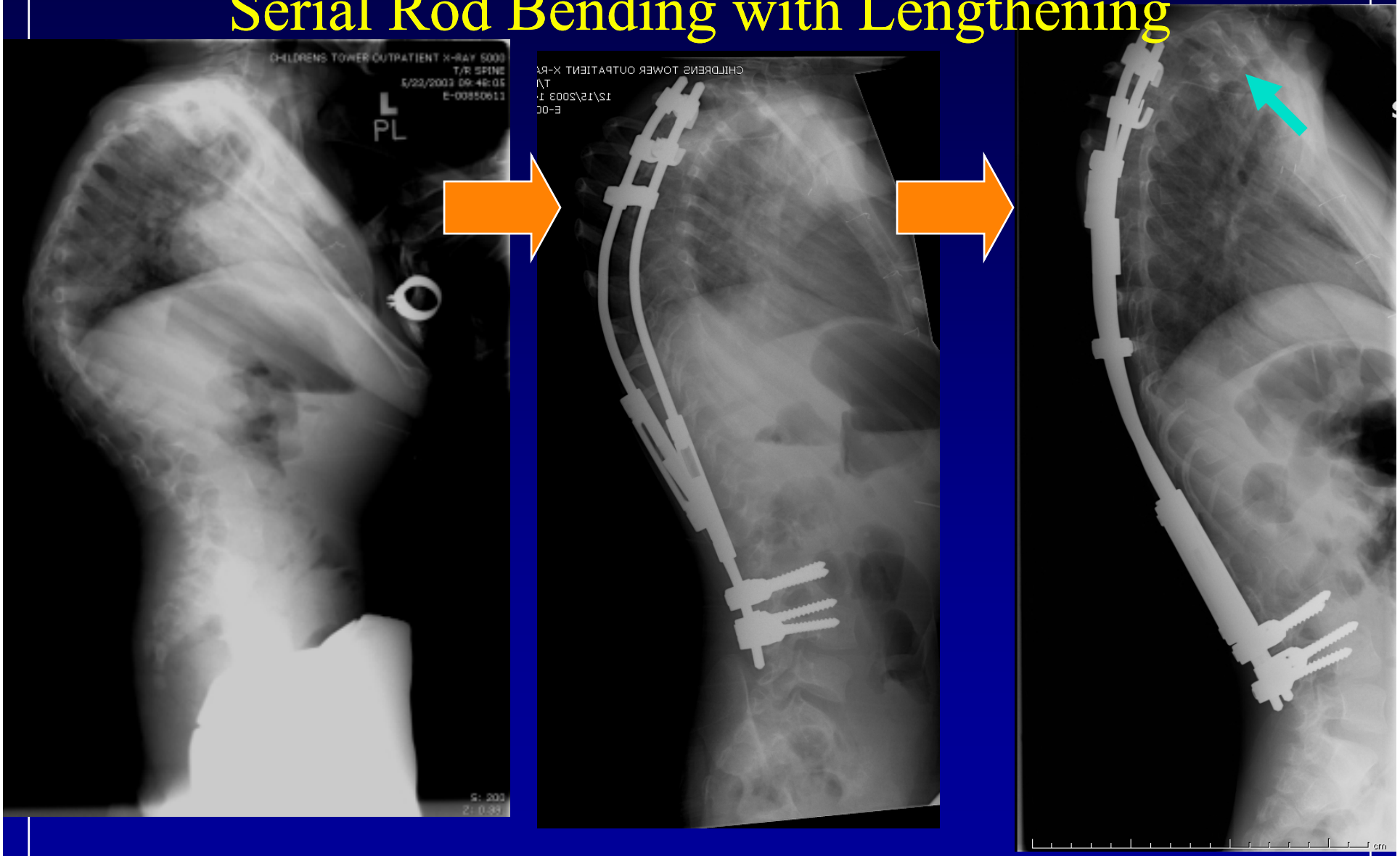
12+7 years



David Skaggs

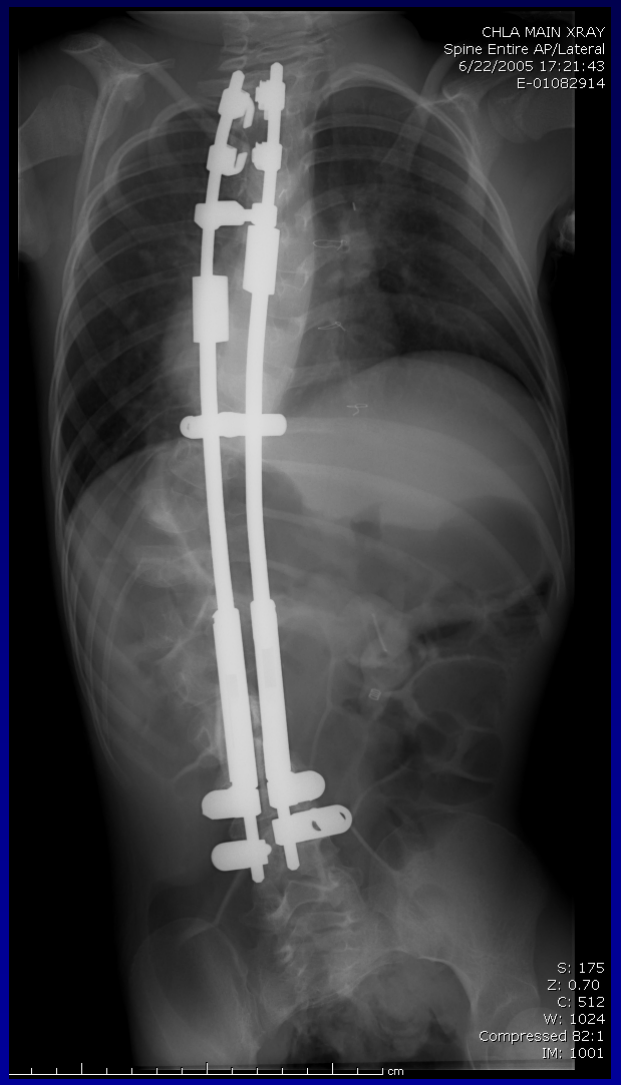


Serial Rod Bending with Lengthening



2 yrs post op

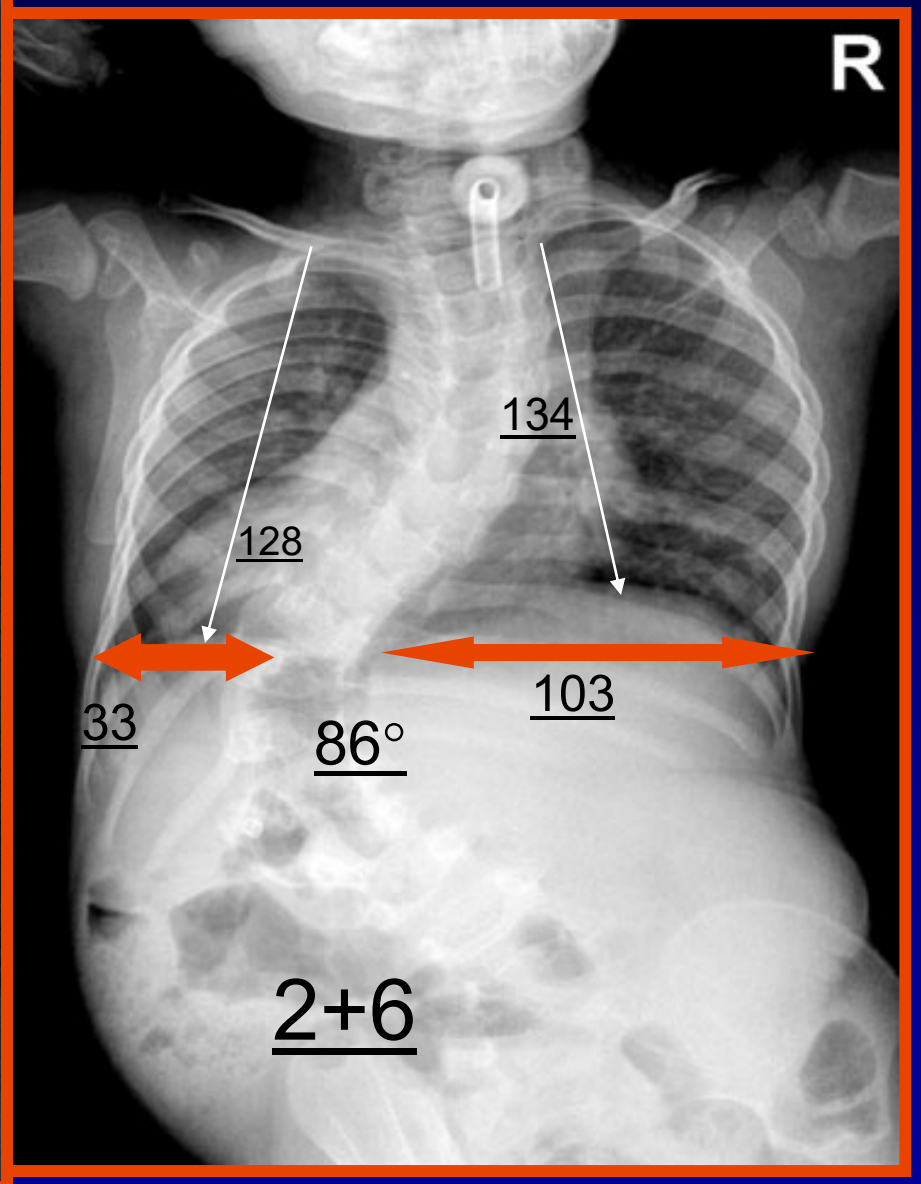

UPRIGHT


CHLA MAIN XRAY
Spine Entire AP/Lateral
6/22/2005 17:21:43
E-01082914
S: 175
Z: 0.70
C: 512
W: 1024
Compressed B2:1
IM: 1001
cm

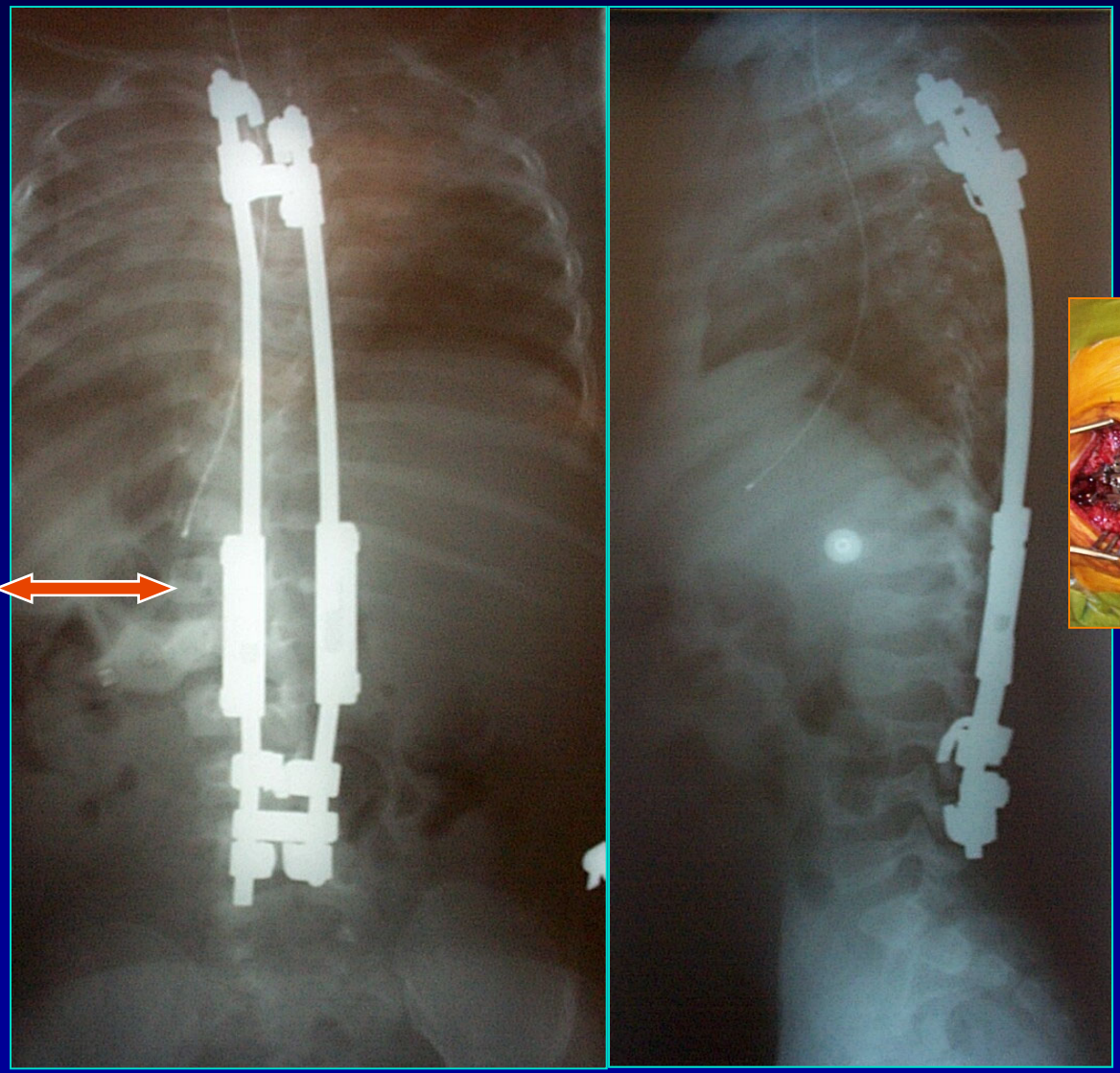
C.C.

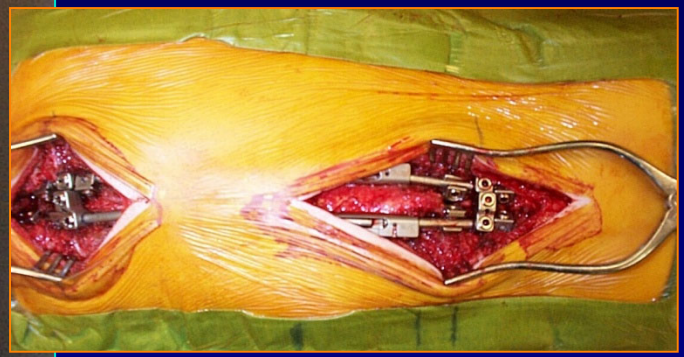
- 9+7 yrs Boy
- Multiple congenital anomalies
  - Tracheomalacia(s/p tracheostomy, g-tube)
  - Normal neuro/development milestones
  - History of multiple pneumonia's
- Initially presented 3/01 at age of 2.5 yrs
  - 20° curve progressed to 68°
  - Failed non operative treatment x one year

Progression

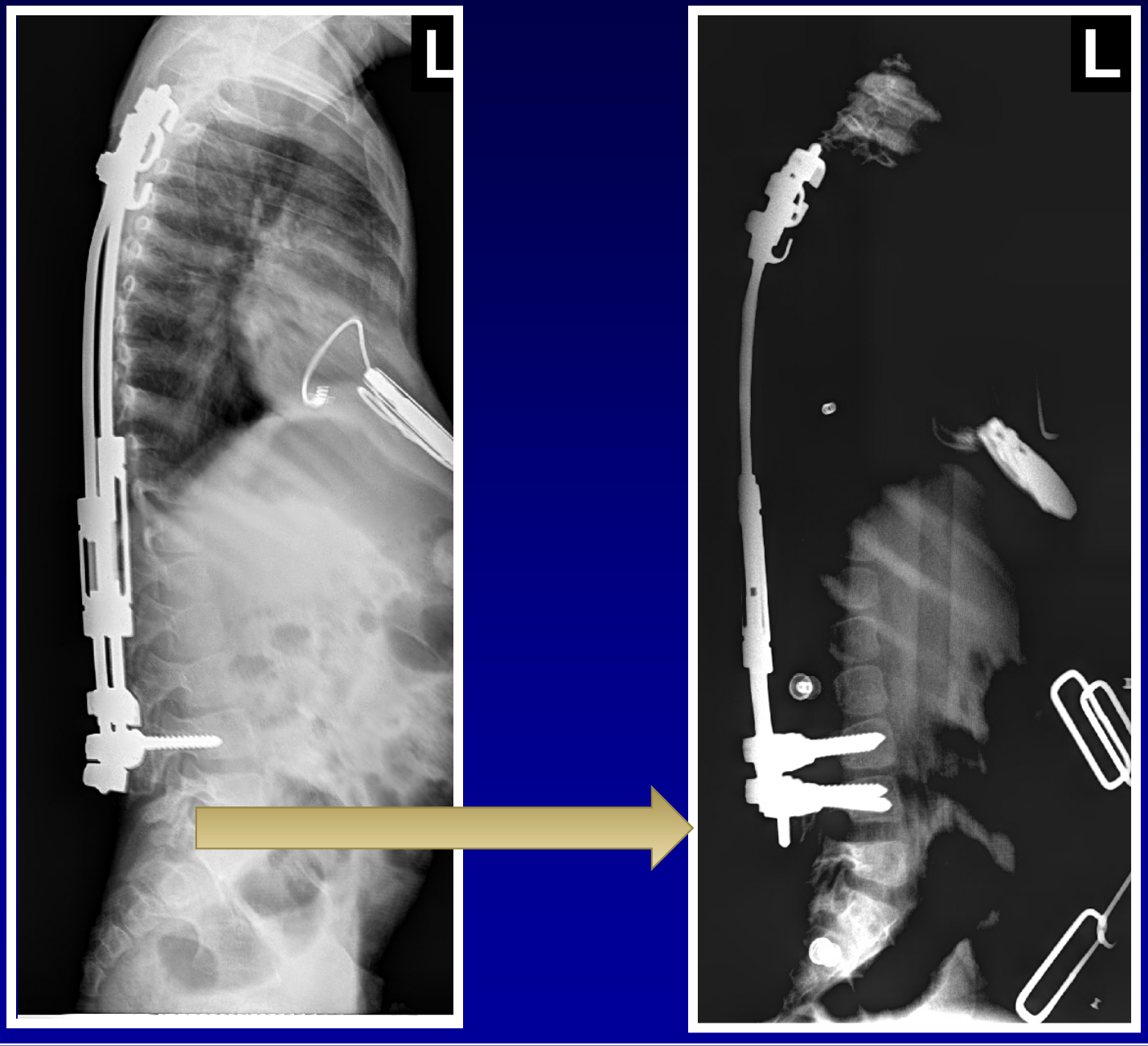


CC 2+6 M.





13 months FU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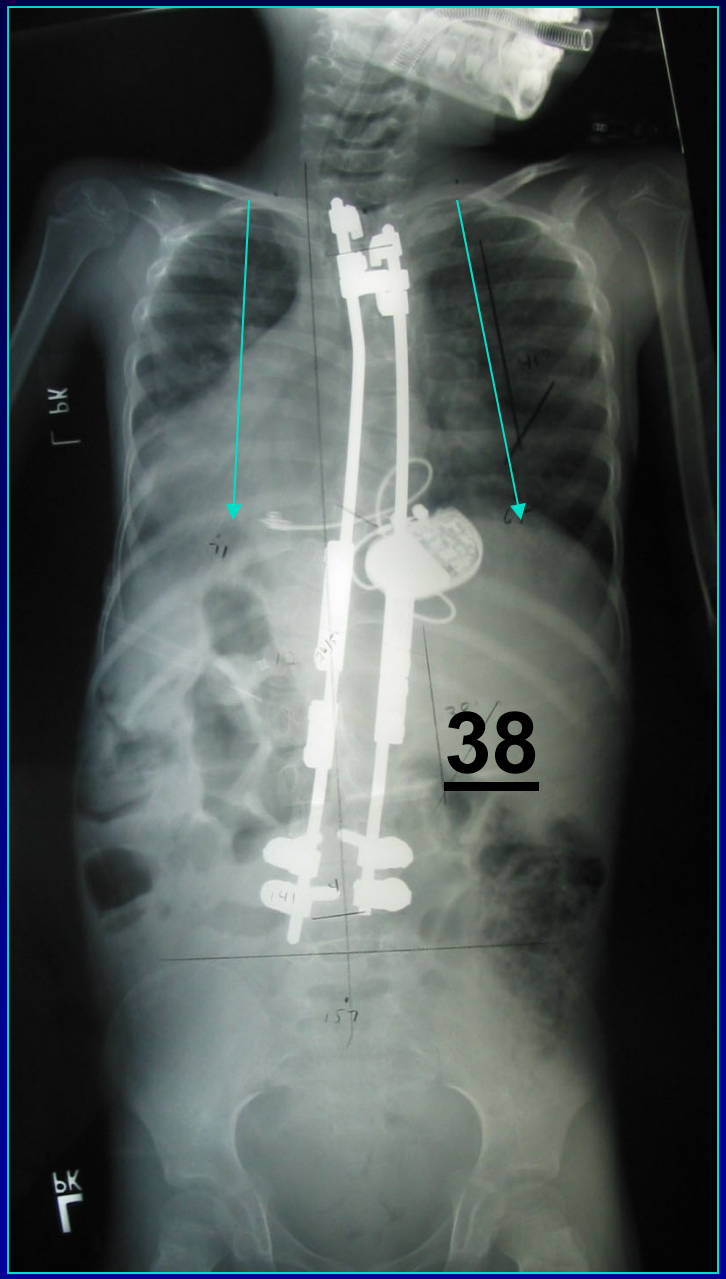


57 months after initial surgery

CC Age 7+3

Cobb:

Pre 86°

FU 38°

T1-S1:

Pre 211mm

Post 247mm

FU 301mm

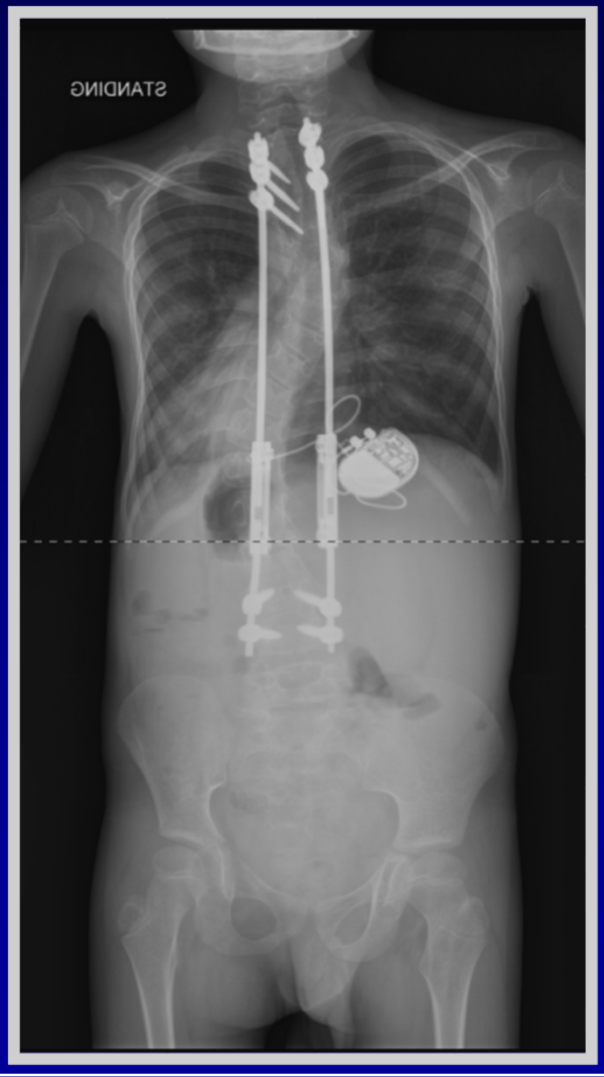
Total 9.0 cm

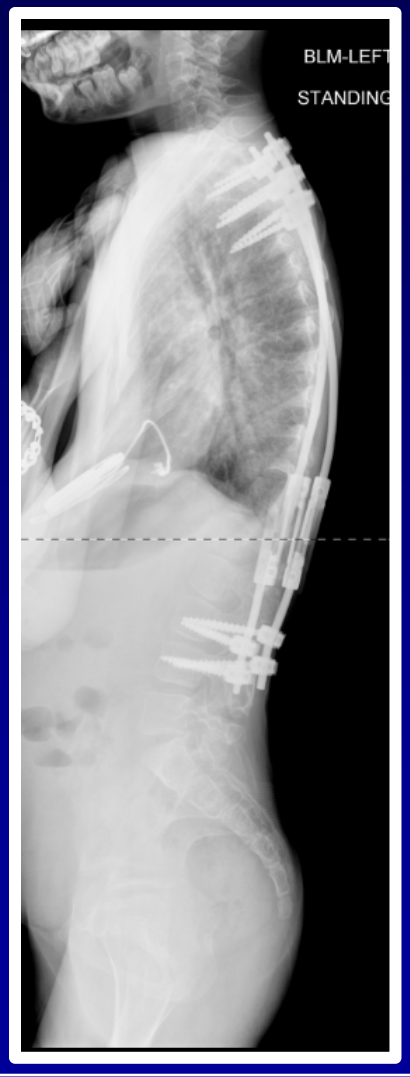
Length. 9

April 2008

- Exploration of fusion
- Removal Implants
- New Implants
- Revision T3-T5

9.3.2008- 7 years post op





- T9-L3 40 deg
- T2-T9 45 deg

Kyphosis

- T3-T12 48 deg
- T12-S1 42 deg

Growth T1-S1
Pre: 211 cm
Post: 247 cm
FU: 338 cm

Total lengh: 12.7 cm

Expected growth: 9 cm

lengthening: 13

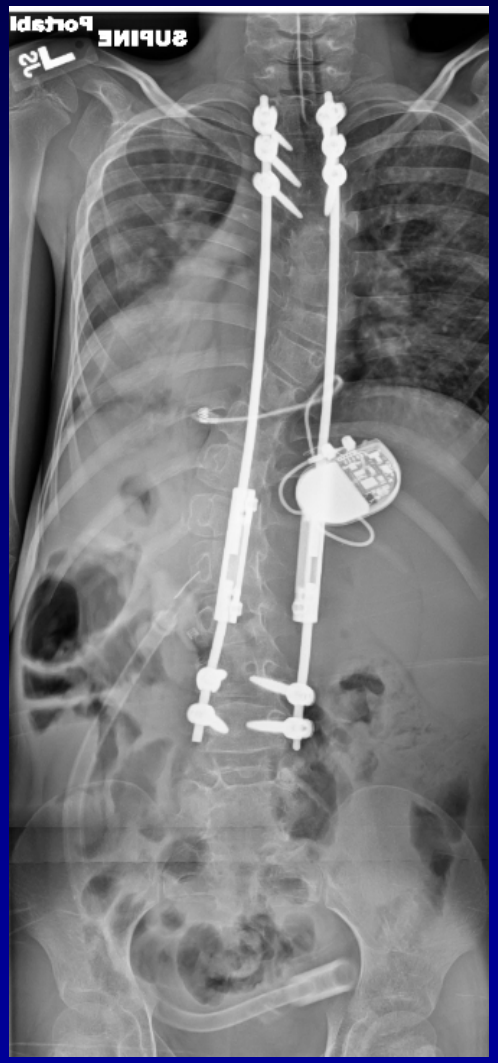
The bumpy road to success

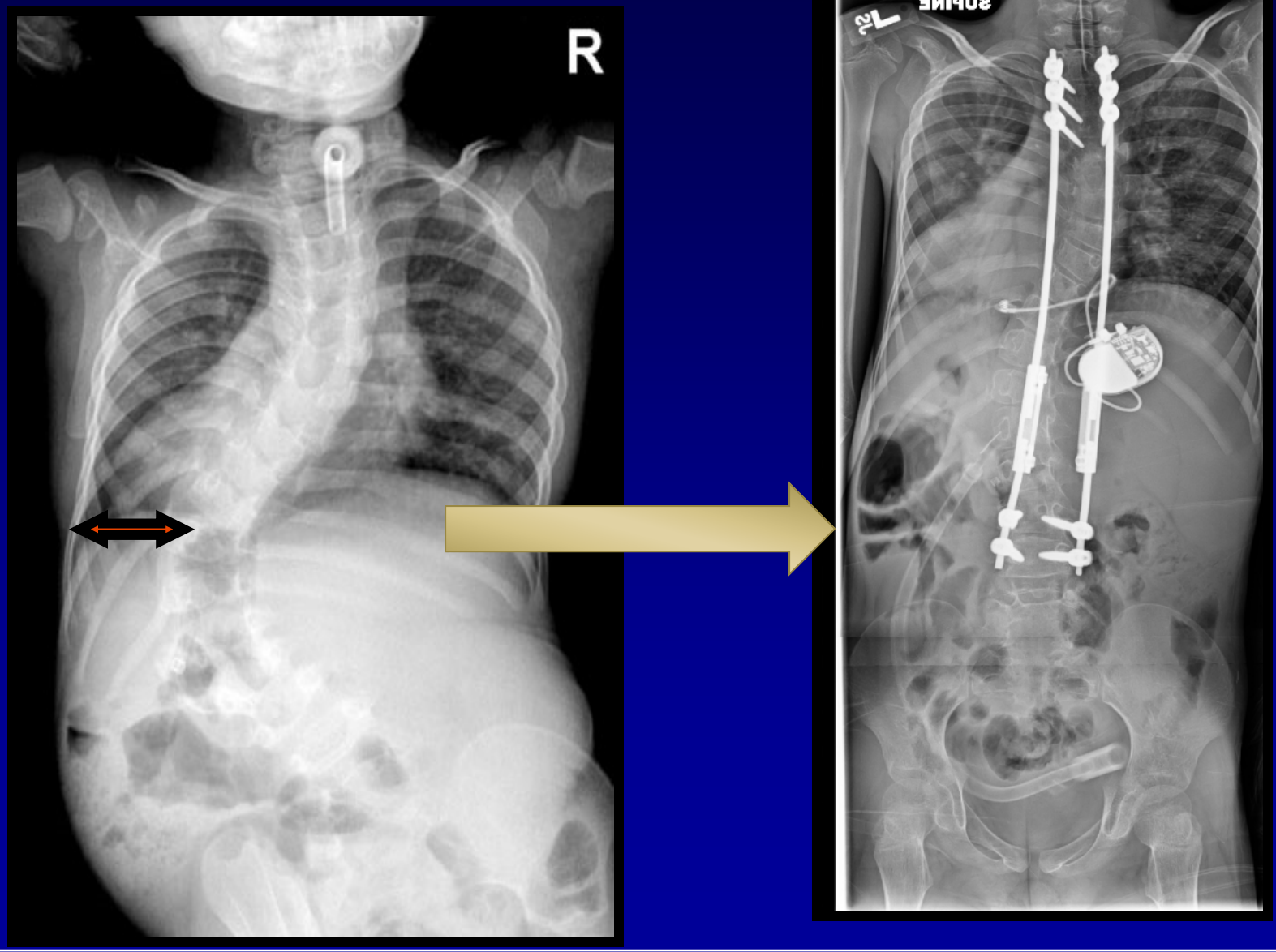
- 9 years and 7 months
- 20 surgeries in last 7 years
- 13 lengthenings
- 6 revision surgeries (instrumentation)
- 5 Irrigation and Debridements
- 3 wound dehiscences requiring OR intervention
- 2 Deep infections requiring PICC line and 6 weeks of abx

Is it worth it?

Yes if:

- Understand risk and benefits
- Consider alternatives
- Do it right the first time
- Family support
- Able to manage the complications




R
SUPINE
Portable

Now…

No Trach. Normal activity

How to Avoid Complications

- Patient selection
- Appropriate surgical planning (levels, techniques of exposure and instrumentation and strong foundations
- Best chance is the time of initial surgery
- Achieve flexibility before instrumentation
- Early detection of potential complications
- Treatment of complication (long term goal)

Thank you