

GROWTH MODULATION

ICEOS ISTANBUL

Early Onset Spine Deformity: Current Status '09



New (old)
ideas for Rx

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Disclosures : Medtronic Sofamor
Danek (research, consultant,
royalties)

Istanbul ICEOS '09

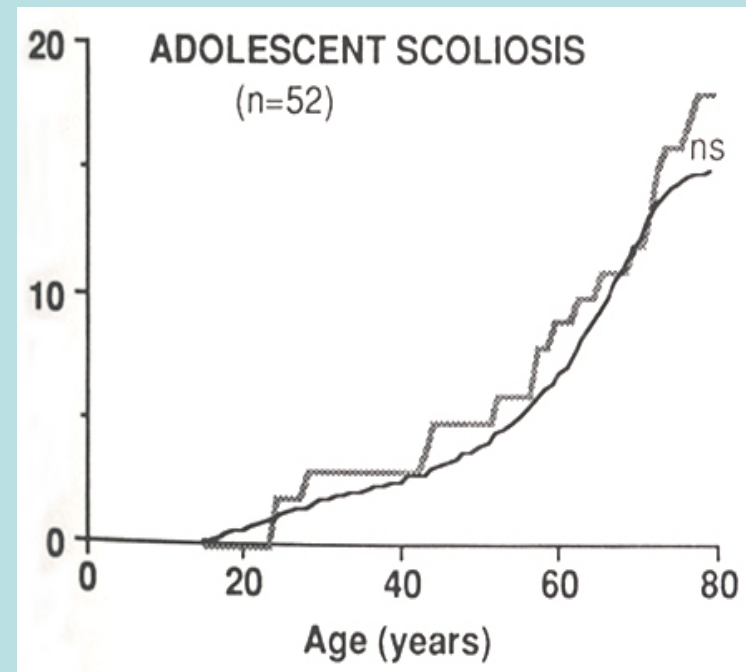
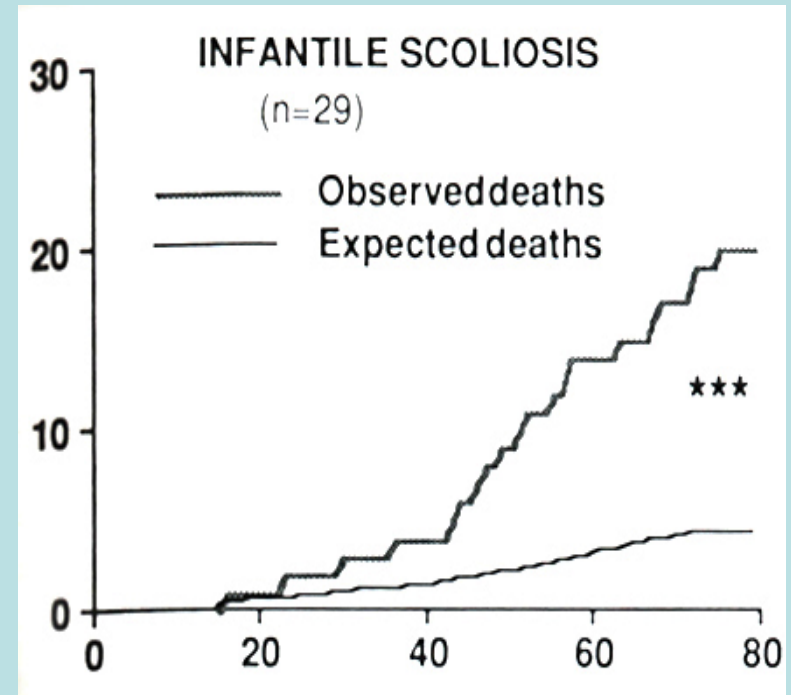
What we know

- Natural Hx untreated EOS



increased
mortality

(Pehrsson, Branthwaite)



EOSD - Dogma

- Untreated/ineffective → T.I.S → early mortality (Pehrsson, Branthwaite)
- Early fusion → T.I.S. → probable early mortality (Goldberg, Karol, Vitale)
- Growth-sparing procedures indicated < age 5-6

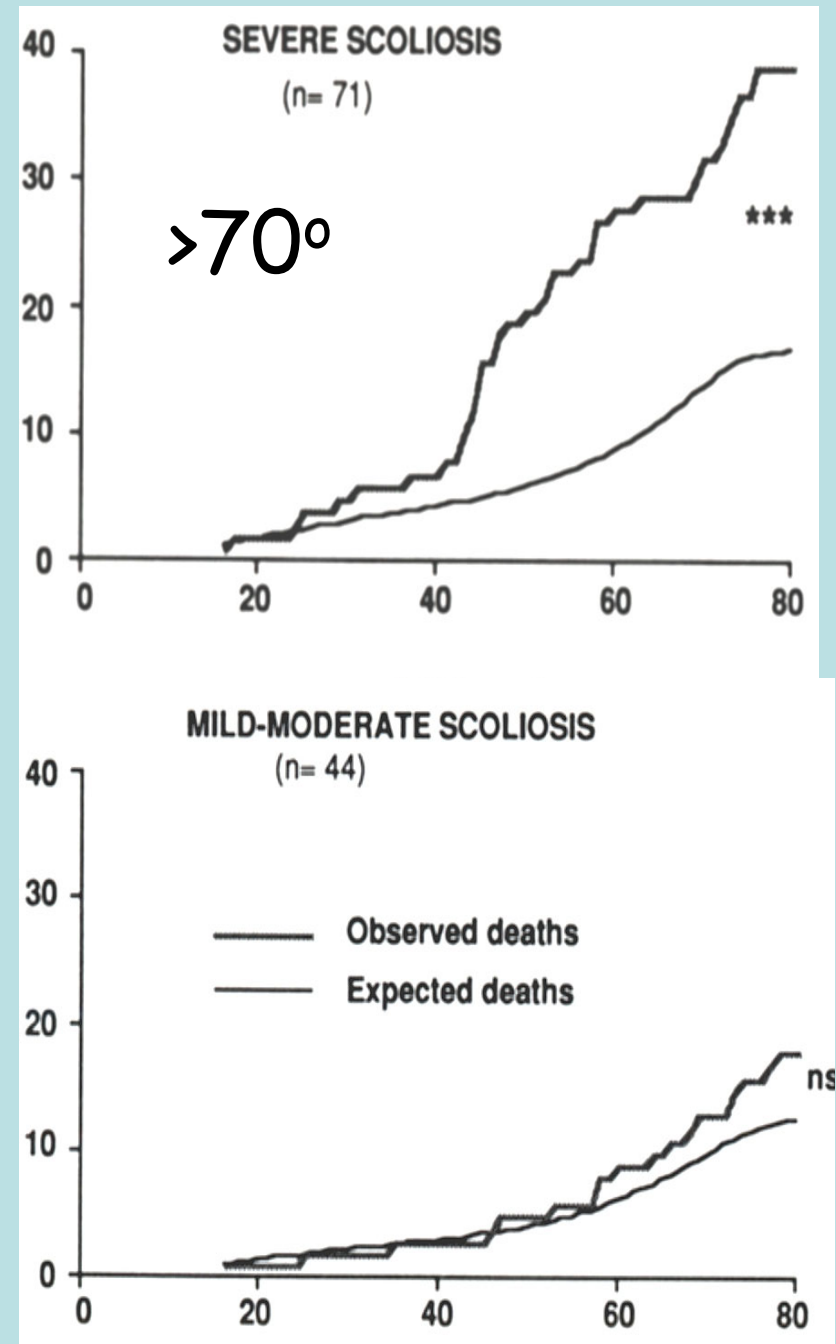
What we know....

- Natural hx large curves



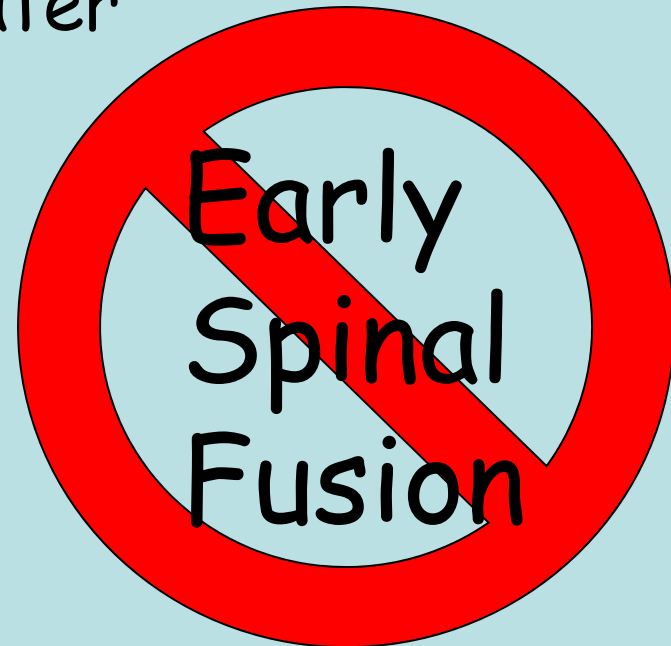
Increased
mortality
(Pehrsson)

- PFT's < 45% pred.
@ maturity



Fusion prior age 4-5

- **Goldberg ('03)** -
"...early surgery,
even with anterior
growth arrest...did
not halt the
deformation of
scoliosis and did not
reliably preserve
respiratory function
in this group whose
scoliosis presented
before age 4."
- **Emans ('04)**
- **Karol ('08)**
- **Vitale ('08)**
- Typical PFT's 20-50%
pred. when tested 10 yr
later



Why modulate ?

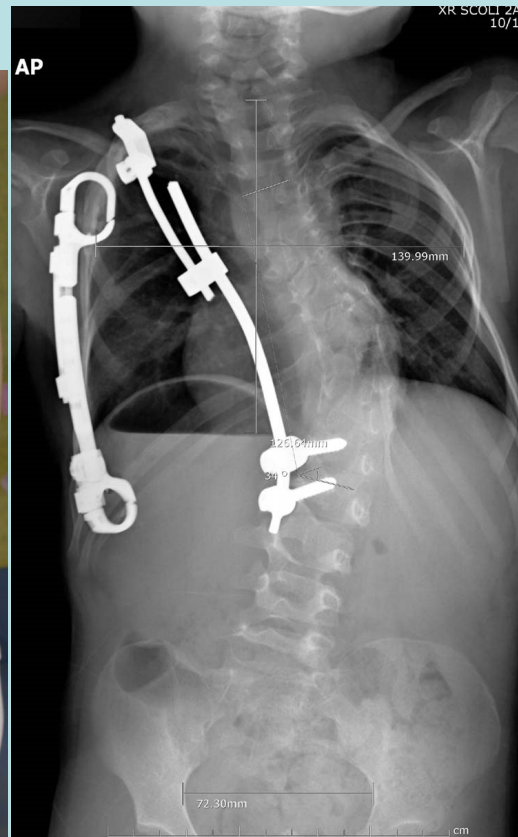
- Decrease morbidity of multiple, serial interventions
- Gradual correction/stablization of spine prevents or improves extrinsic chest wall deformity (windswept thorax)
- Preserve motion/disc+facet function
- BIG RESEARCH QUESTION
Ability to create deformity =
ability to correct deformity ??

Serial Distraction Methods

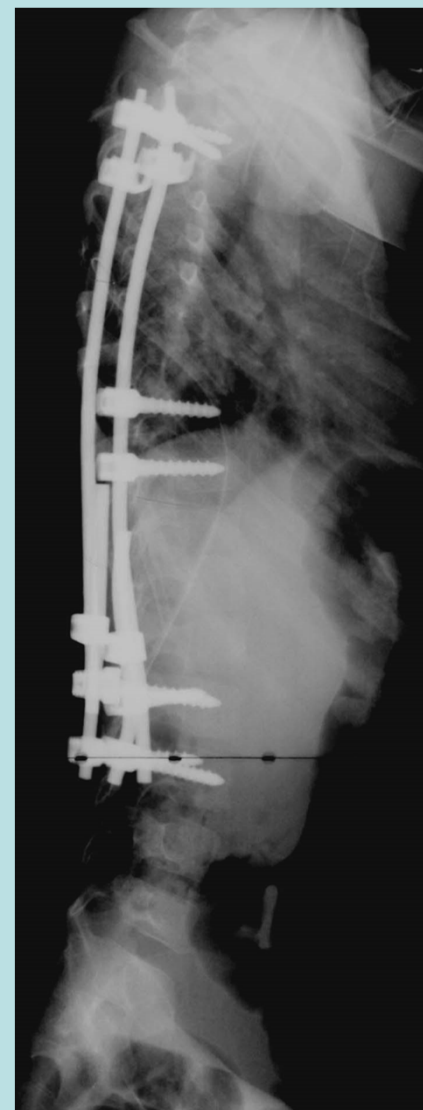
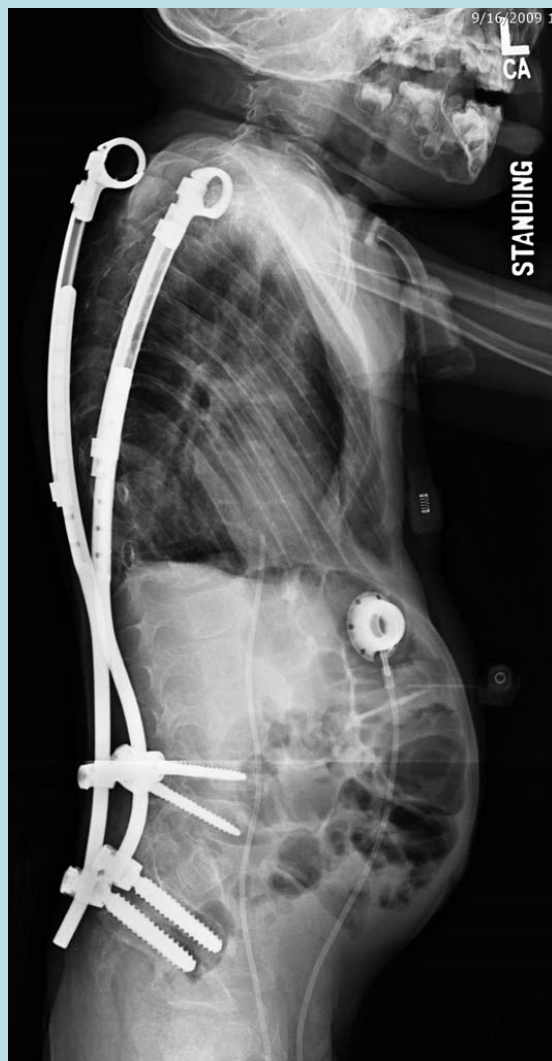
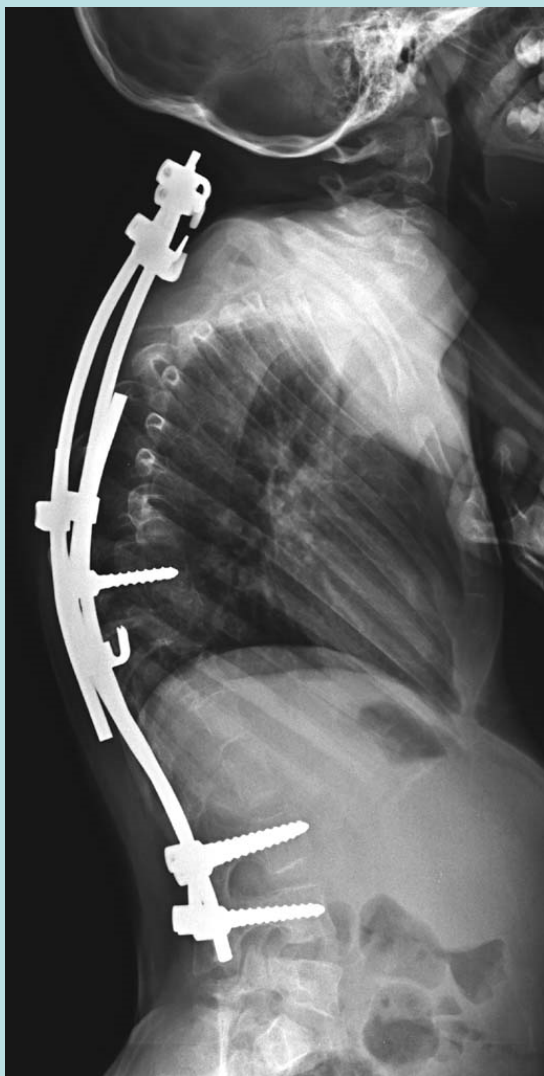
- Lots of complications 2° repeated procedures  Infection, rod fx ankylosis, dis-anchoring
- Bad for sagittal plane  Junctional kyphosis
- Little effect on axial plane  No rx for windswept deformity

Wound Problems

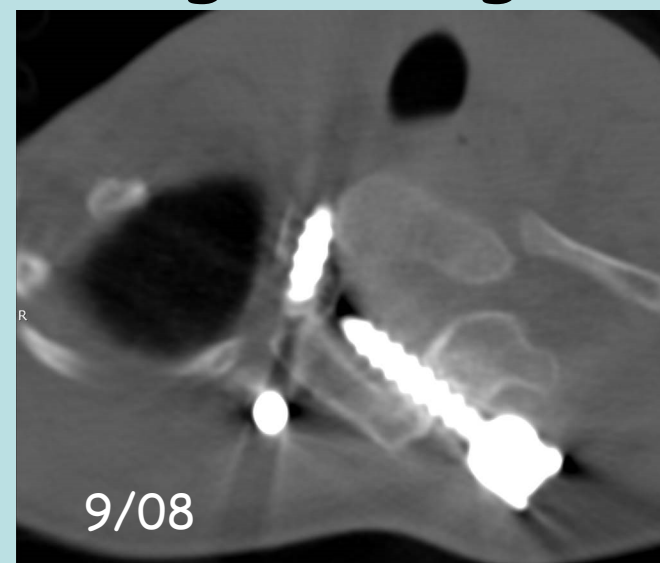
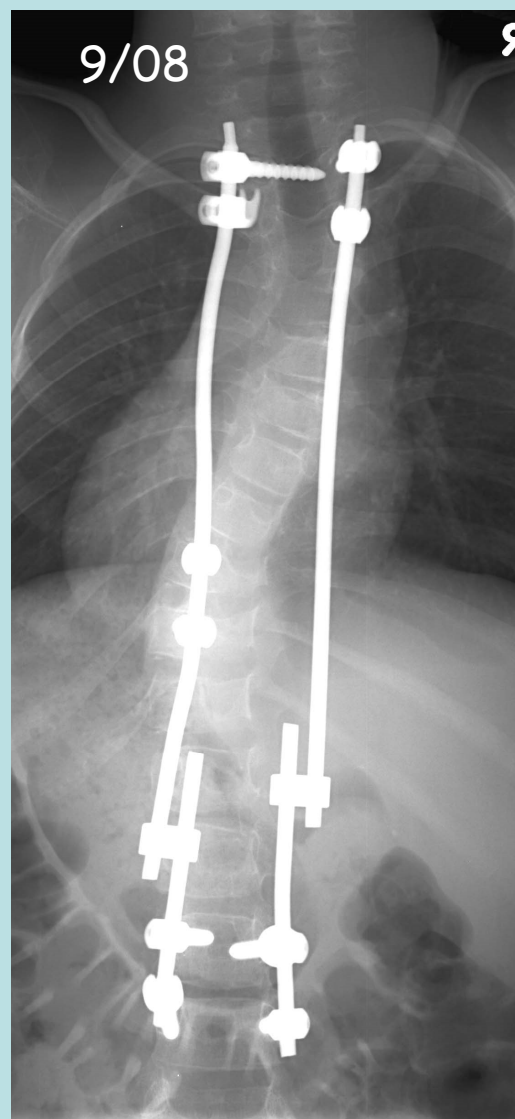
- Implants increase prominence as skin stretched



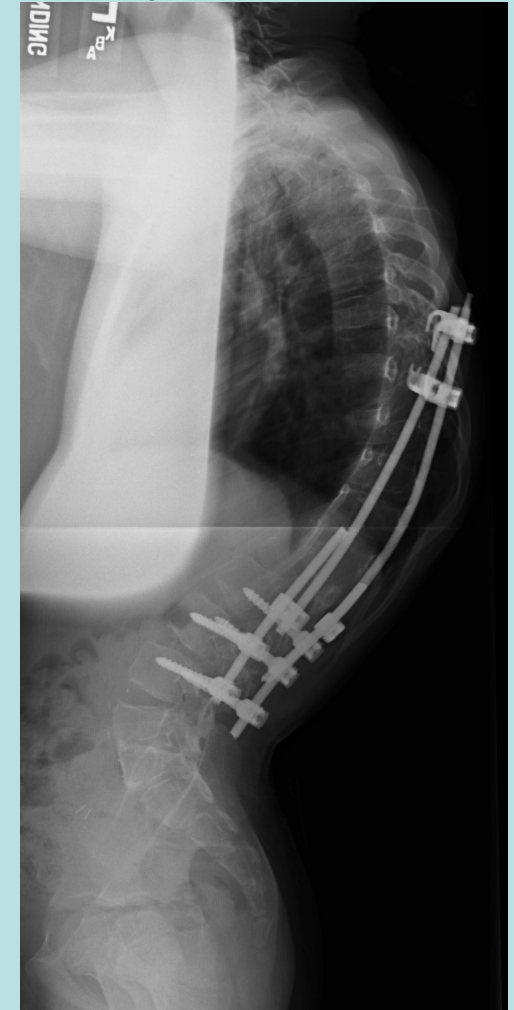
Dis-anchoring



Spastic paraparesis, urinary retention 5 mo after last uneventful lengthening



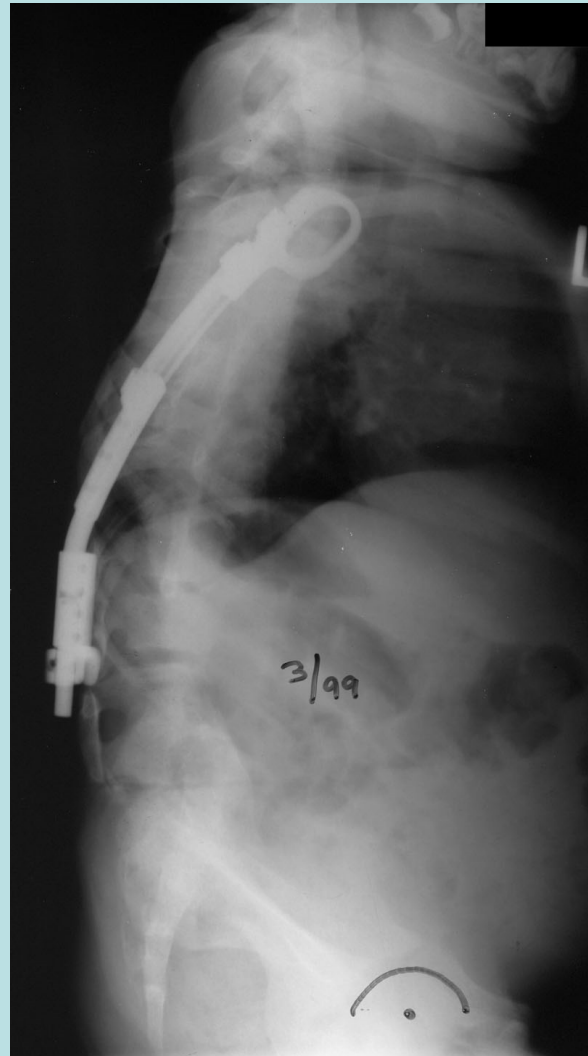
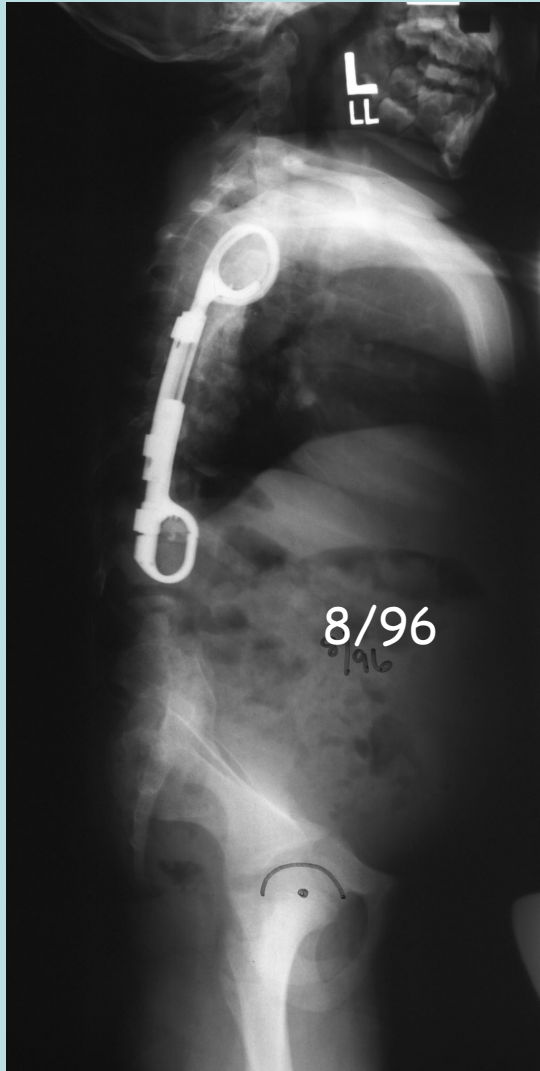
More length $\Rightarrow$ shift + j.k.



Revision for alignment complications $\rightarrow$

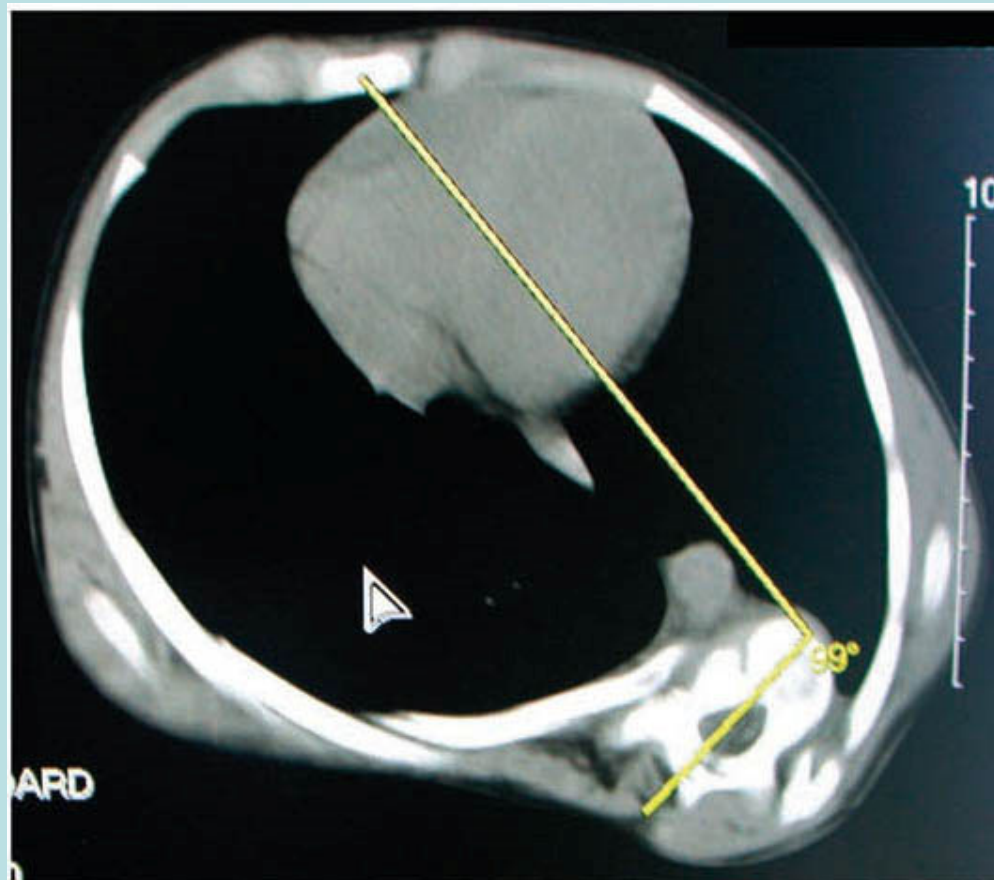
Infection $\rightarrow$ Implant removal

Hybrid device flattens L spine 2° repeated distractions ?

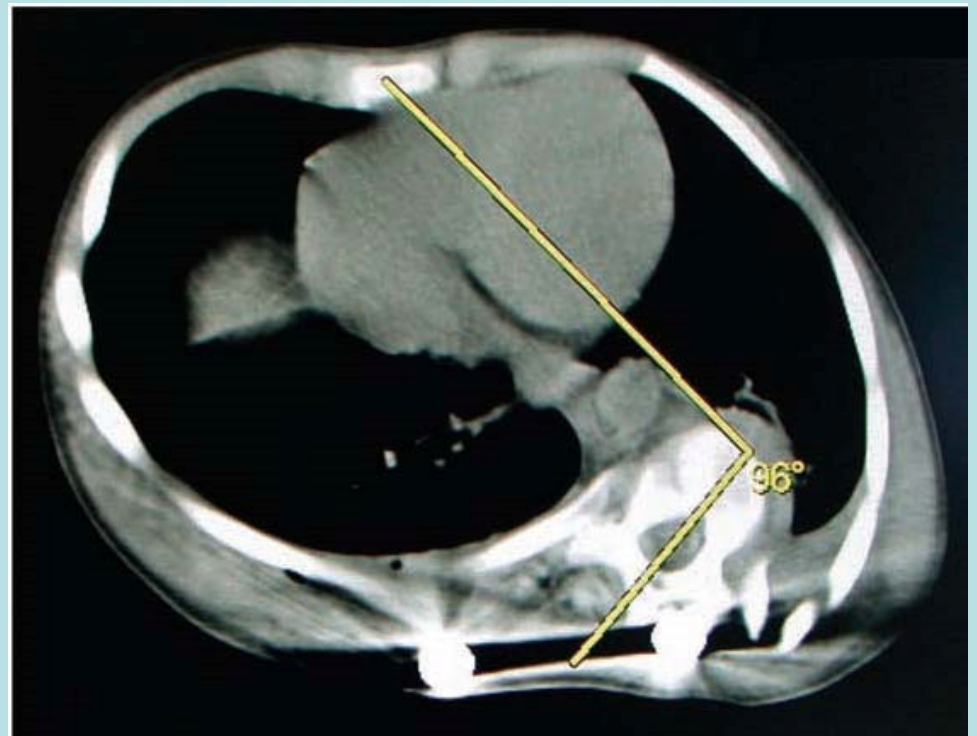
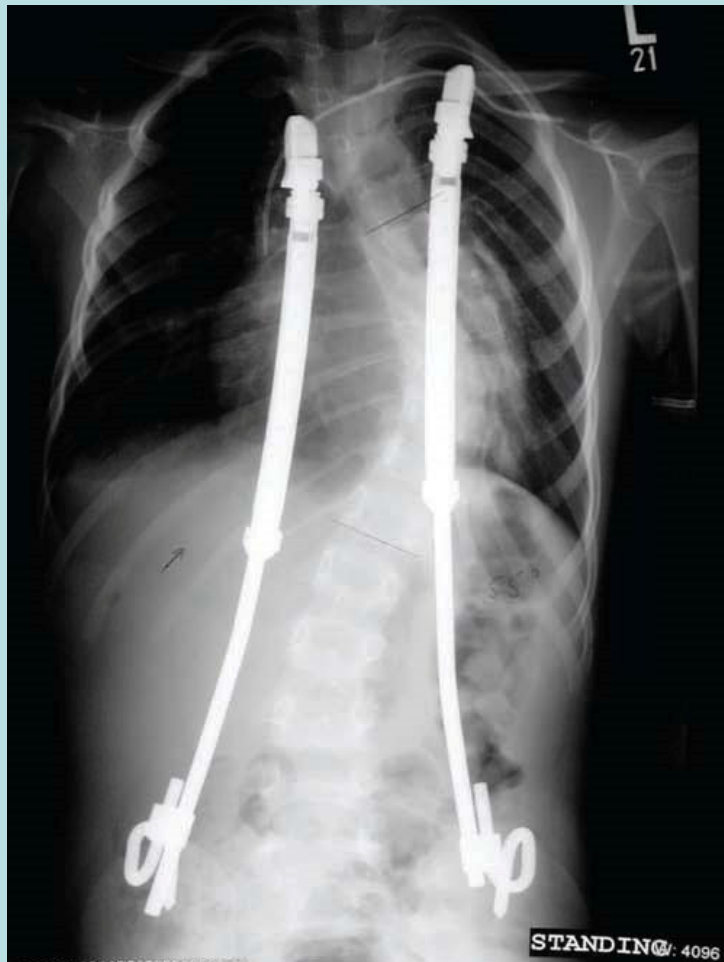


Veptr and windswept correction

(Campbell/Smith JBJS '07 supp)



Postop - no improvement
Distraction inefficient to correct axial
plane deformity



Why modulate ?

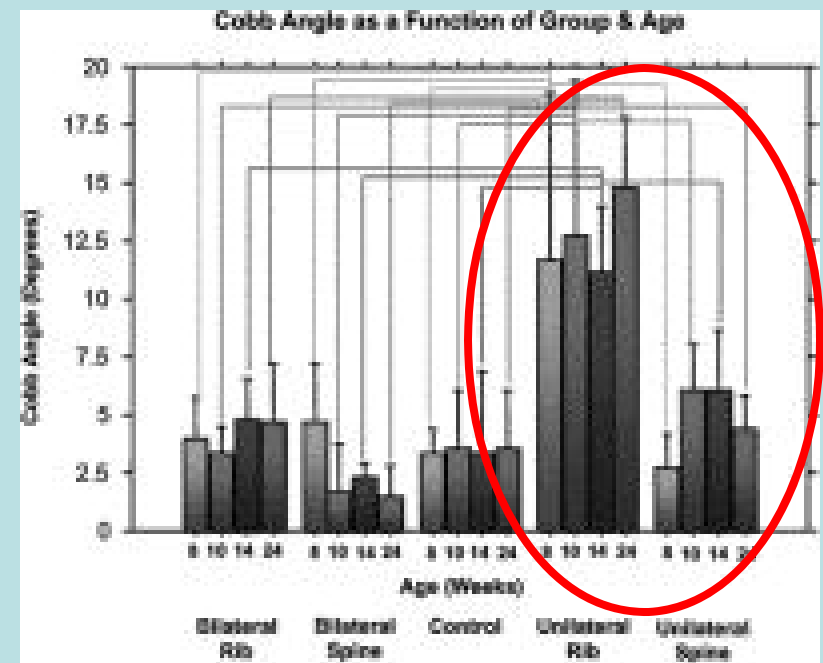
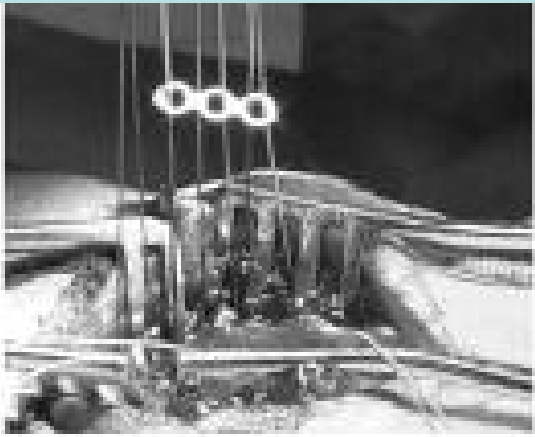
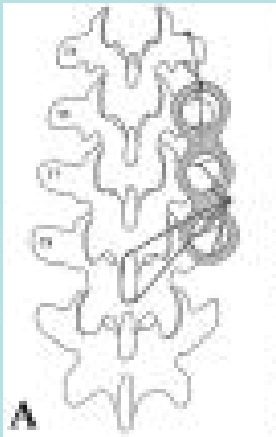
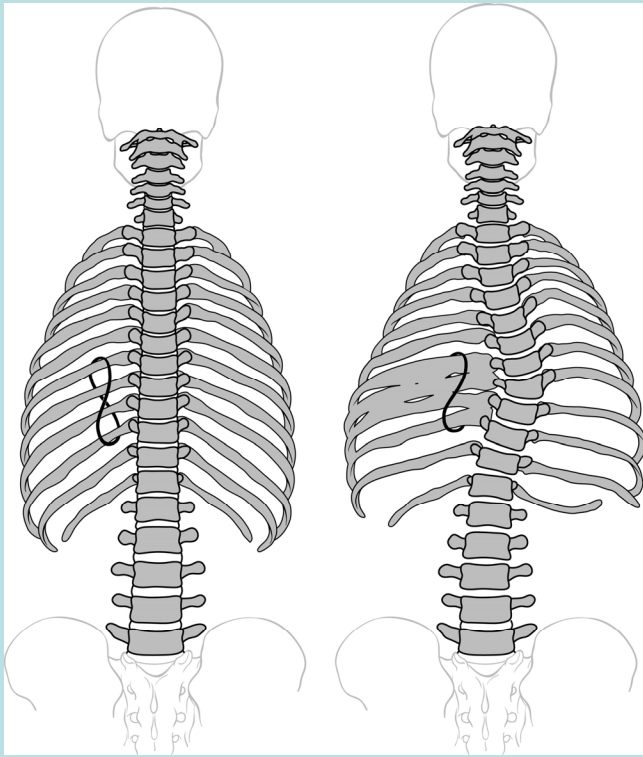
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History - Ribs

- Growth of Th spine and ribs inter-related
 - Disturb growth of one → disturbs the other, especially in proximal Th area
1. Canavese / prox. thor. fusion → hypoplasia of ribs, sternum, thorax, decreased lung volume
 2. Carpintero / asymmetric tether T1-3 → larger curve > mid thor. tether
 3. Mehta&Snyder / asymmetric rib tether → larger curve > spine tether at same level
 4. Sevastik, Agadir / rib elongation → concavity of scoliosis
 5. Langenskiold, Sevastik, Deguchi / rib resection → larger curves > rib shortening

Rib vs. Spine Effect (Mehta/Snyder)

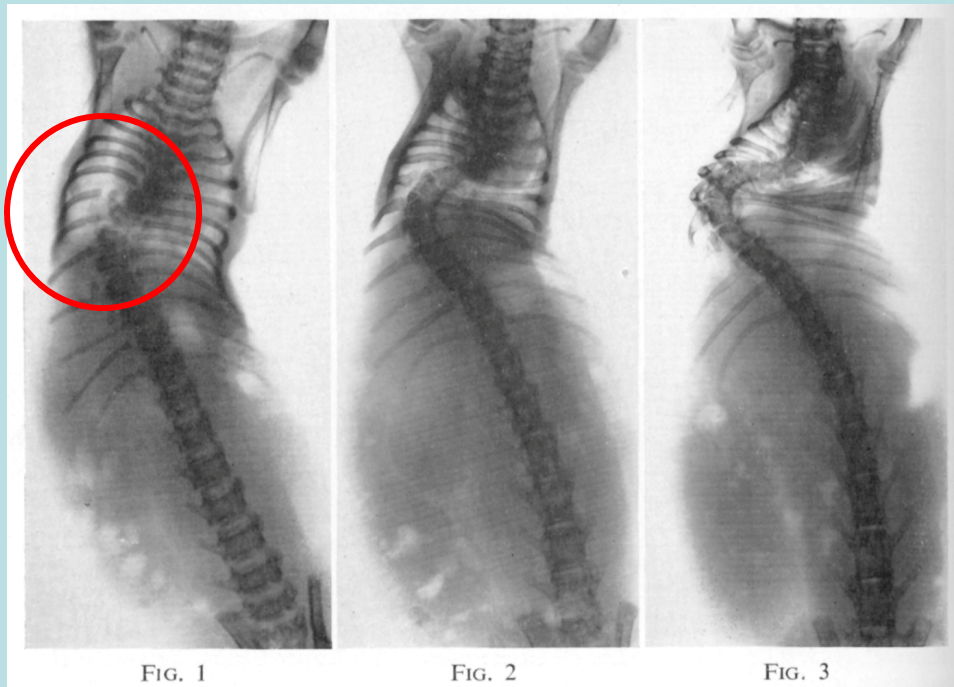
Rib tether → longer
moment arm > t.p.
tether = larger curves



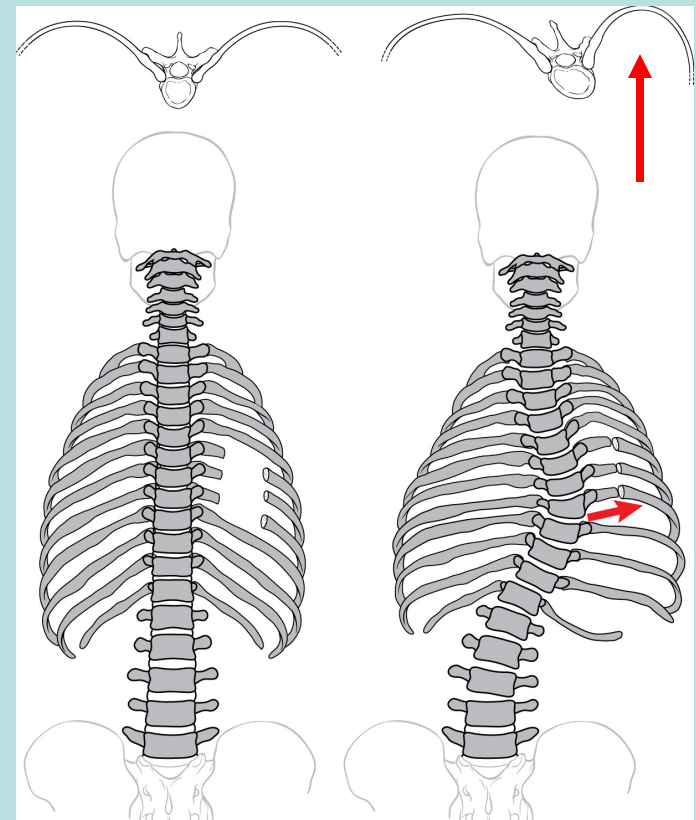
Classic animal model

Langenskiöld ('60's)

- Rib resection (=shortening) → severe scoliosis



Destabilize convexity +
concave ribs elongate



Newer Animal Model

Pinealectomized Chickens

(Deguchi et al '90s)

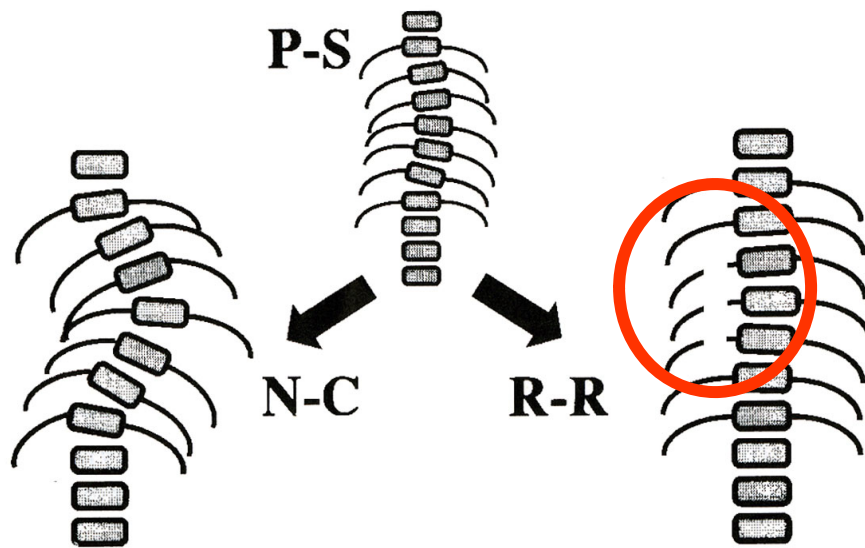


FIG. 1. Hypothesis: Rib resection may suppress the progression of scoliosis or reduce curvature when it is done on the concave side of the curve at an early stage of the growth period. R-R, rib resection; P-S, progressive scoliosis; N-C, natural course.

- Pinealectomy-produced curves = "systemic" effect
- **Concave** apical rib resection @ 2 or 4 wk. (depending on curve reaching $>20^\circ$) = "local" effect
- Curve control / suppression observed

Curve Suppression (Deguchi)



FIG. 2. Severe scoliosis in subgroup A1.



Chicken in subgroup B1 at 20 weeks of age. The curve was reduced by rib resection done at 2 weeks of age. A Cobb angle of 24° was present. The resected ribs showed healing at 16 weeks.

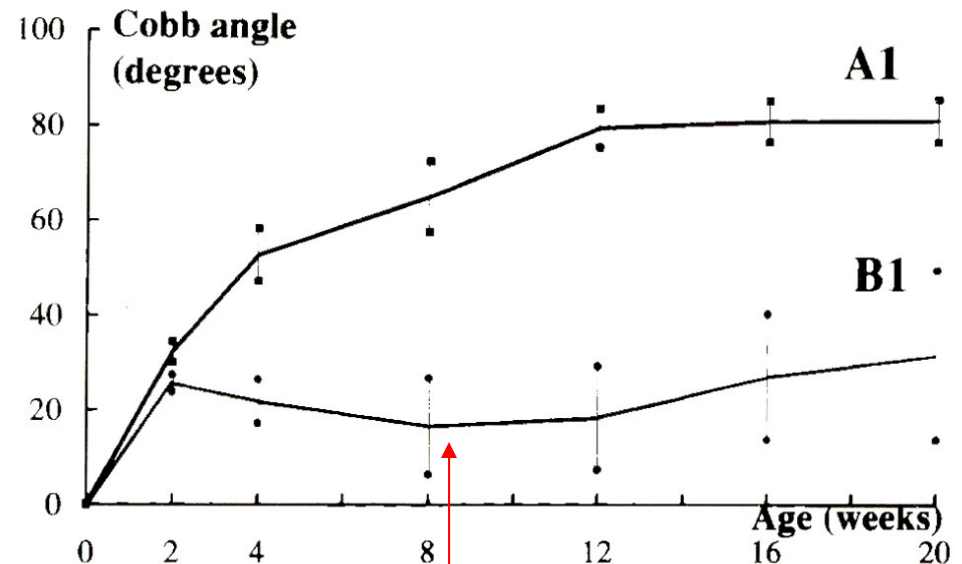
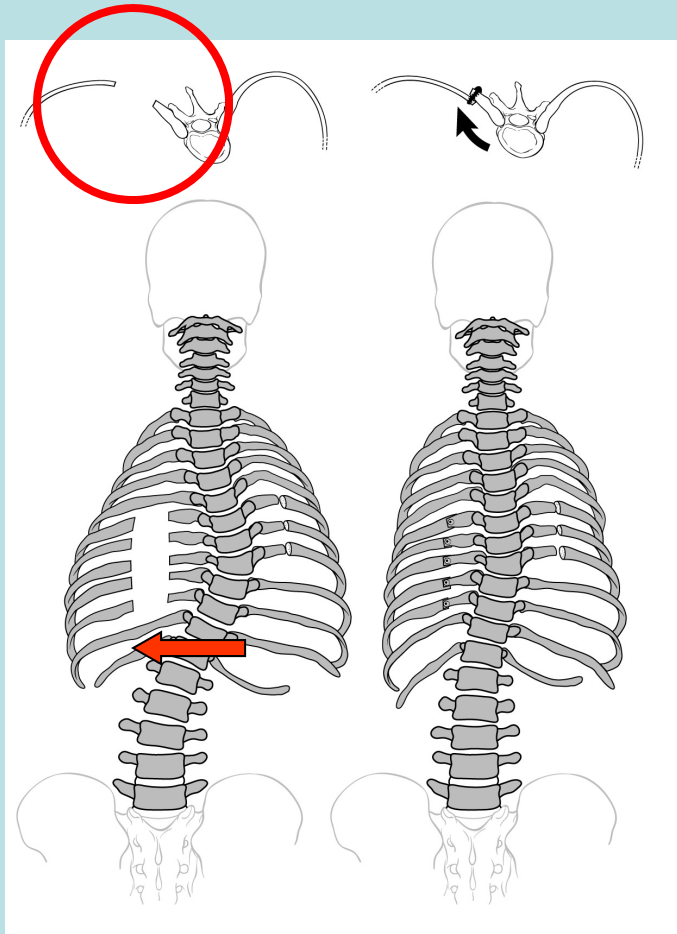


FIG. 3. Course of progression of scoliosis in subgroups A1 and B1. Mean value and standard deviation in each subgroup was shown. Note that subgroup A1 chickens developed scoliosis rapidly until 12 weeks of age and gradually after that, whereas progression of the scoliosis in subgroup B1 chickens was suppressed after 2 weeks of age. Repression of the curvature occurred after 8 weeks of age.

Ribs healed after 8 weeks - thorax "stable" allowing re-progression

Rib Shortening vs. Lengthening

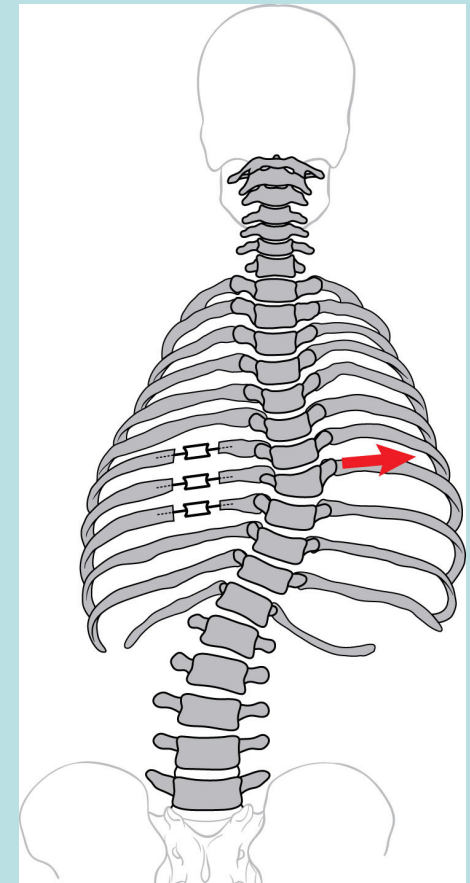
Sevastik et al '90



Limited effect after
initial acute changes in
coronal plane (rib
continuity restored)

(10% correction
predicted by Montreal
simulation C-E Aubin)

Not as
"effective" as
resection



Concave Rib Resection for IIS

Piggott ROH Birm (53-B:663, 1971)

- Mean curve 64°
- 6 ribs/heads, postop not specified
- 23/25 $<10^{\circ}$ prgrsn @ 29 mo (6-57) f/u
- 7 improved $>10^{\circ}$

Barnes RNOH (61-B:31, 1979)

- Mean curve 80°
- Apical 4 ribs, cast x 2 mo, then MB
- 23/48 $<10^{\circ}$ prgrsn @ 6 yr (3-9 $\frac{1}{2}$) f/u
vs. 5/19 cast/brace only $<10^{\circ}$ prgrsn

Rib resection - Discussion

- Piggott - "several curves have shown significant regression...operation has had a favourable influence...at a relatively early attempt at assessment. ...therapeutically worthwhile....especially in children under five years old
- Barnes - "...no significant differences in either change of angle or rate of change of angle between patients of the two groups."

Clinical Application - Rib

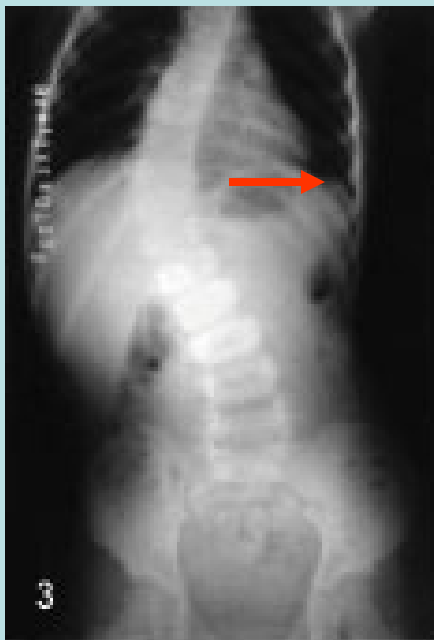
Eur Spine J (1998) 7:505–508
© Springer-Verlag 1998

CASE REPORT

B. Xiong
J. A. Sevastik

A physiological approach to surgical treatment of progressive early idiopathic scoliosis

3 apical concave ribs shortened 2 cm



7 y.o. 46°



15 mo p.o. 30°



27 mo p.o. 21°

Rib Rx for EOS

- Abandoned - prematurely?
- Active research in deformity creation

THE NEW YORK TIMES, WEDNESDAY, JUNE 27, 2007

BASEBALL

Chiropractor Puts Four of Damon's Ribs Back in Place

By TYLER KEPNER

BALTIMORE, June 26 — The fastest way for Johnny Damon to feel better, it seems, is to visit his chiropractor in Orlando, Fla. That is what he did Monday, after an earlier appointment to see a dentist, and the results had him feeling rejuvenated.

"We've definitely got to get him on the payroll," Damon said of the chiropractor, Dr. Gerry Mattia. "The guy's magic."

Damon, who started only once in Colorado and San Francisco because of a sore rib cage, said Mattia discovered immediately that four ribs on his right side were out of place. Mattia fixed the problem over two visits — one Monday, another Tuesday morning — and Damon was back in the lineup Tuesday night, leading off at designated hitter.

"I feel like a different person," Damon said, adding later: "Just after he did it, I was like, 'Wow, how come I'm feeling so much better?' I'll take it."

Damon, who has also been bothered by problems with his calves and back this season, has embraced the role of designated hitter. But he said Tuesday that he hoped to return to center field.

"I actually want to worry about the field," he said. "I can still go get it. It's just unfortunate how the season started with the strained calf. But that feels pretty good. I want that



Barton Silverman/The New York Times

Johnny Damon said he felt rejuvenated yesterday after visiting his chiropractor on Monday in Orlando, Fla.

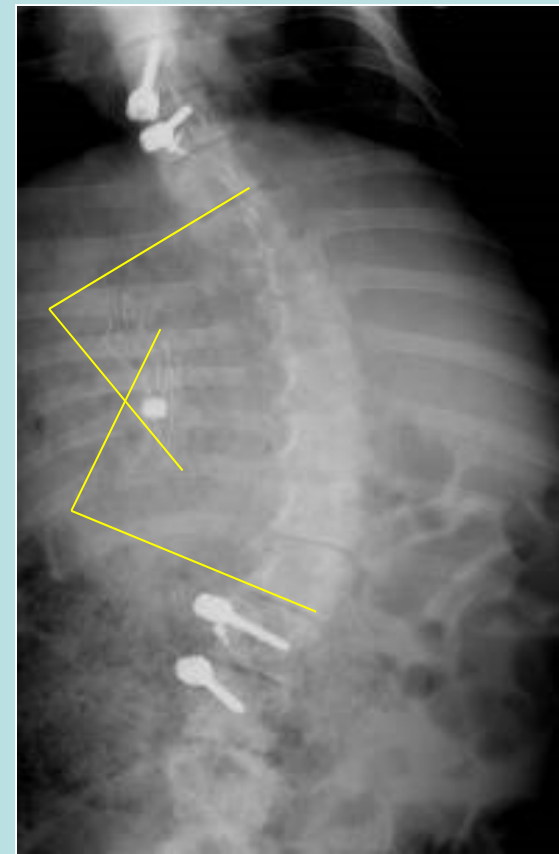
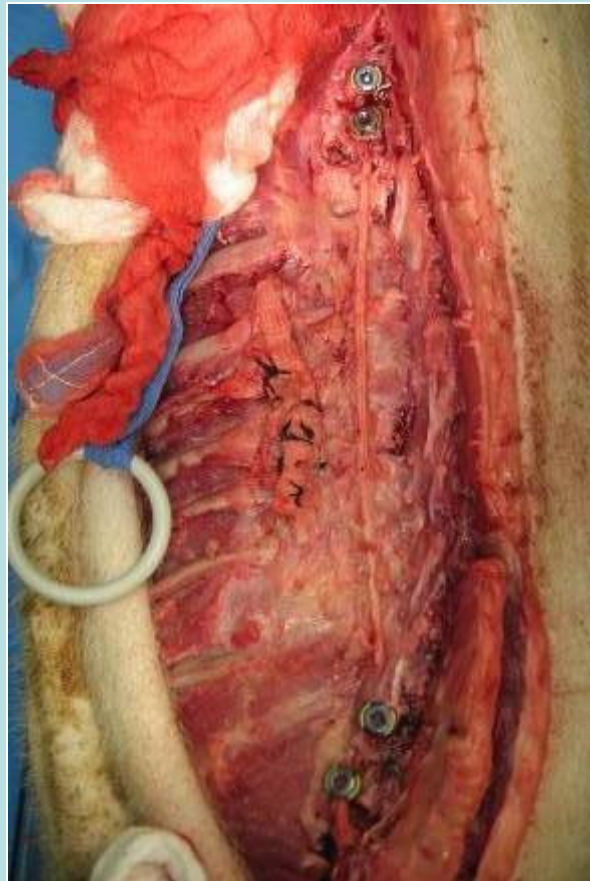
Newer Methods → Big Curves

- Spine +/- rib tethers (staples, cables)

Lafage/Schwab, Braun, Mehta/Snyder, Newton

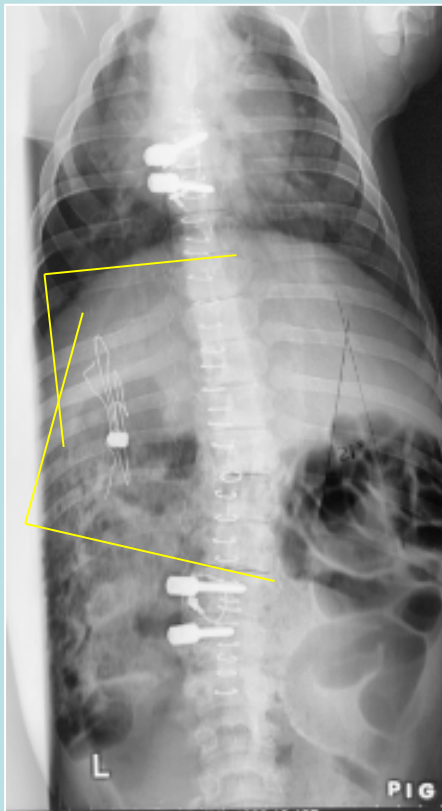
Unilateral rib
+ spine only

No
contralateral
rib resection

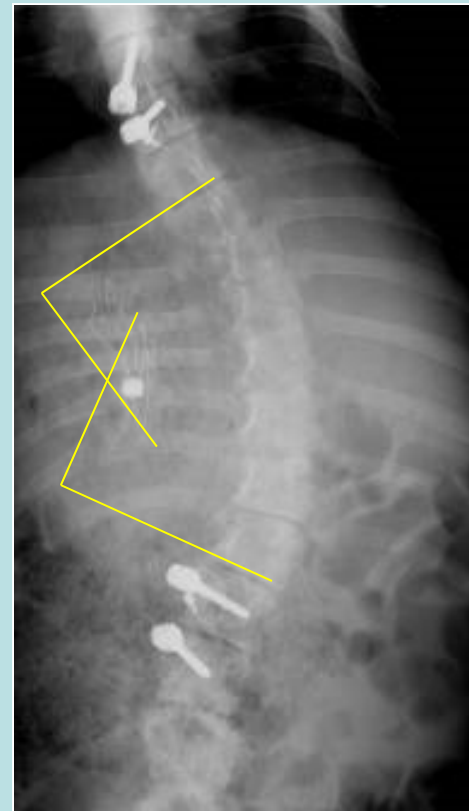


Curves progression: 11 animals

Coronal Curve Progression



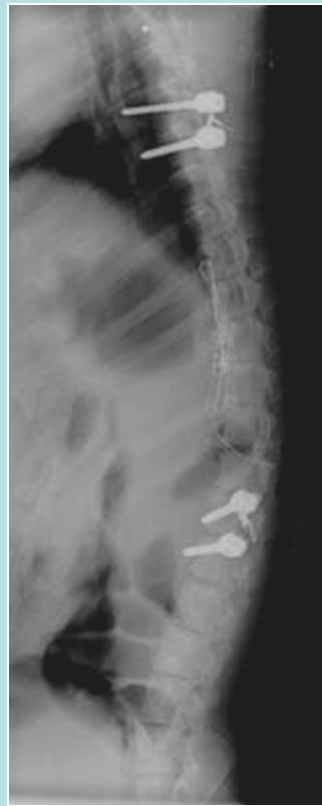
Immediate Post-Op
26 degrees



Last Follow-up
52 degrees

Curves progression: 11 animals

Sagittal Curve Progression



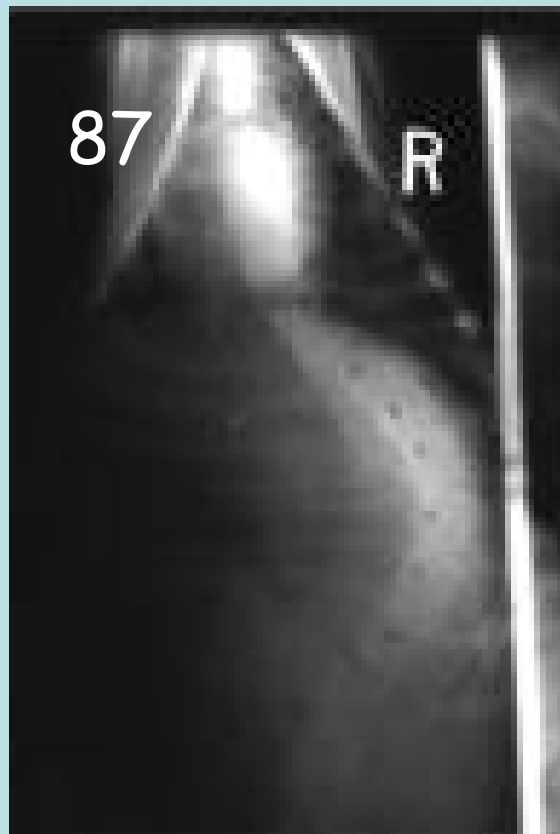
Immediate Post-Op
7 degrees



Last Follow-up
27 degrees

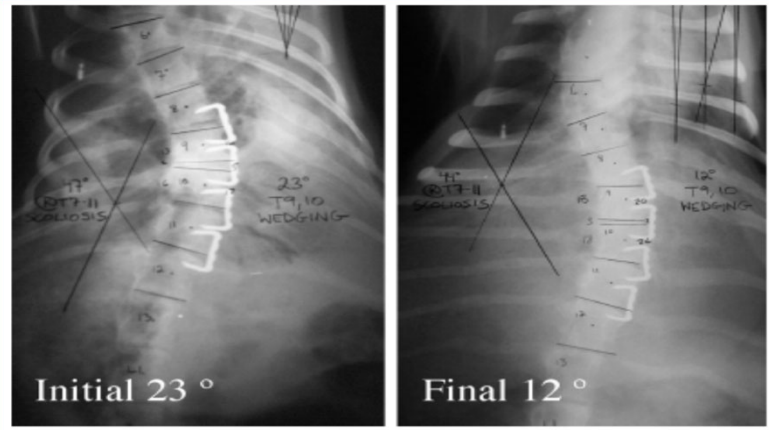
Newer Methods - Spine + Ribs (Braun)

- Flexible tether of spine with rib resection (immediate big curve + progression)

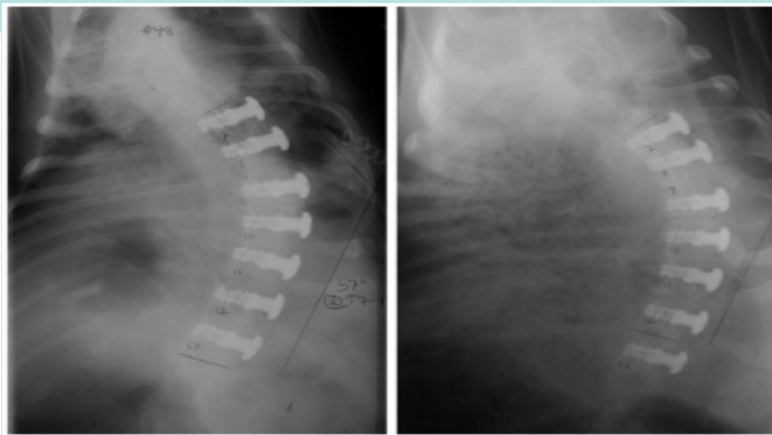


Lordosis

Correct/suppress (Braun)

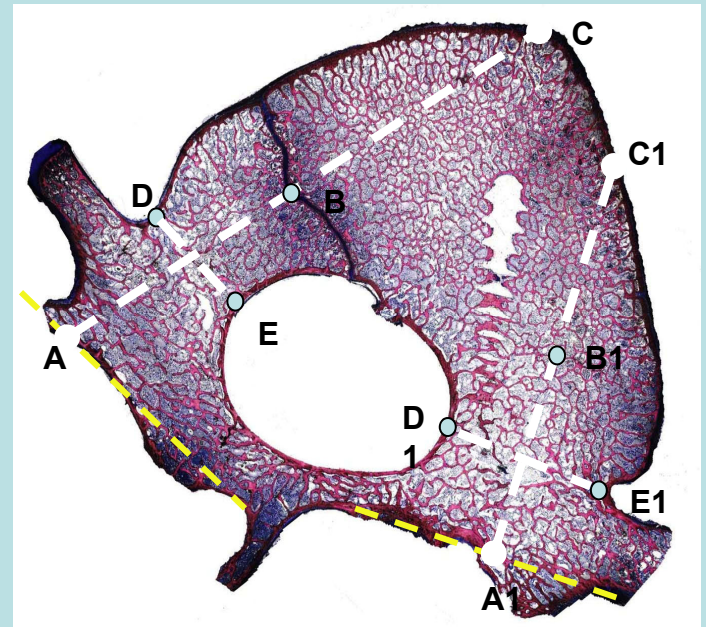
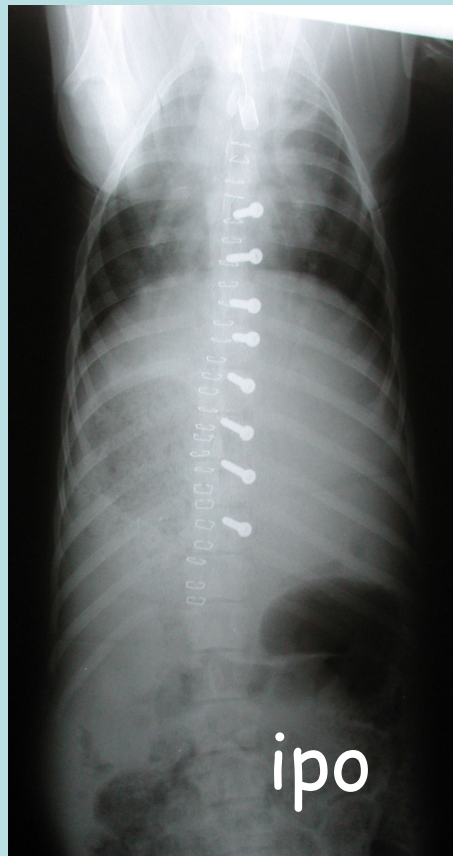


Not enough
growth
remaining
following curve
development to
fully assess
corrective
efficiency ???



Newer Methods

- Neurocentral synchondrosis arrest
(Beguiristain, Zhang/Sucato)

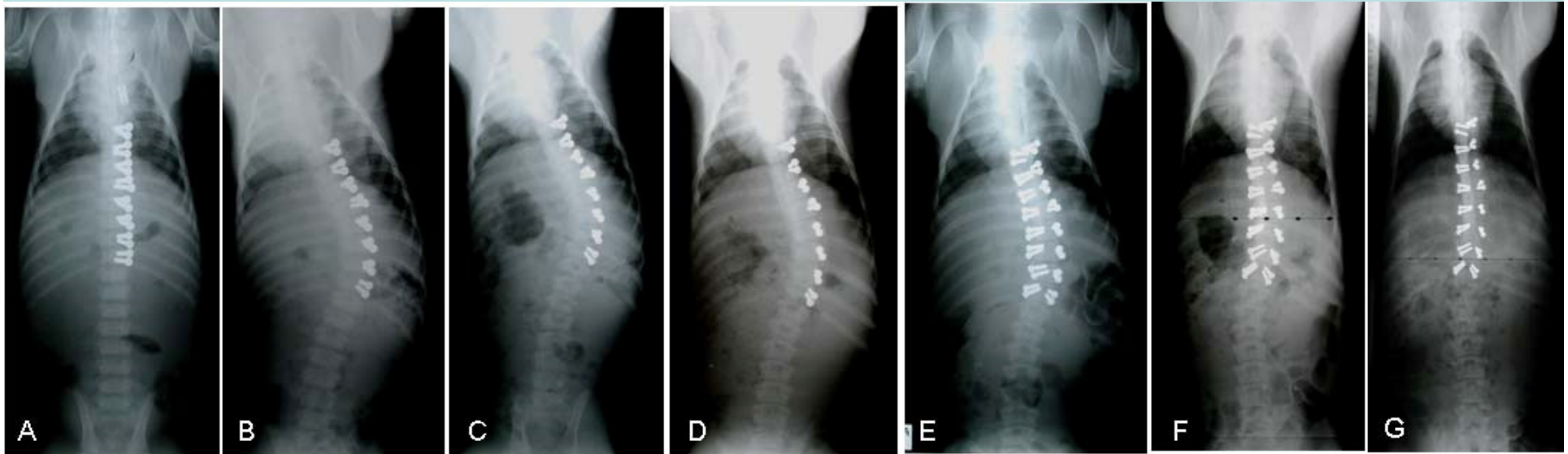


Concave pedicle
longer > convex

Deformity Correction - NCS modulation

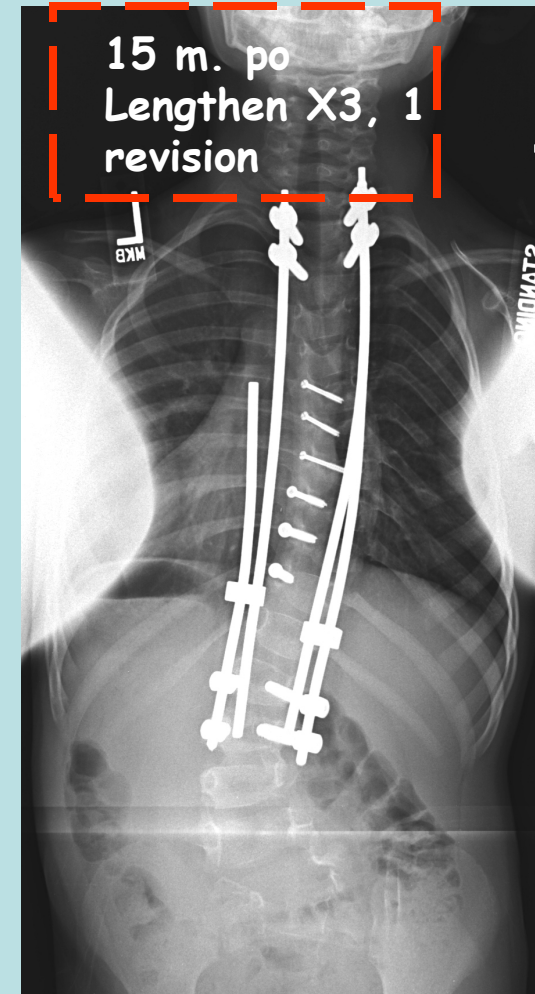
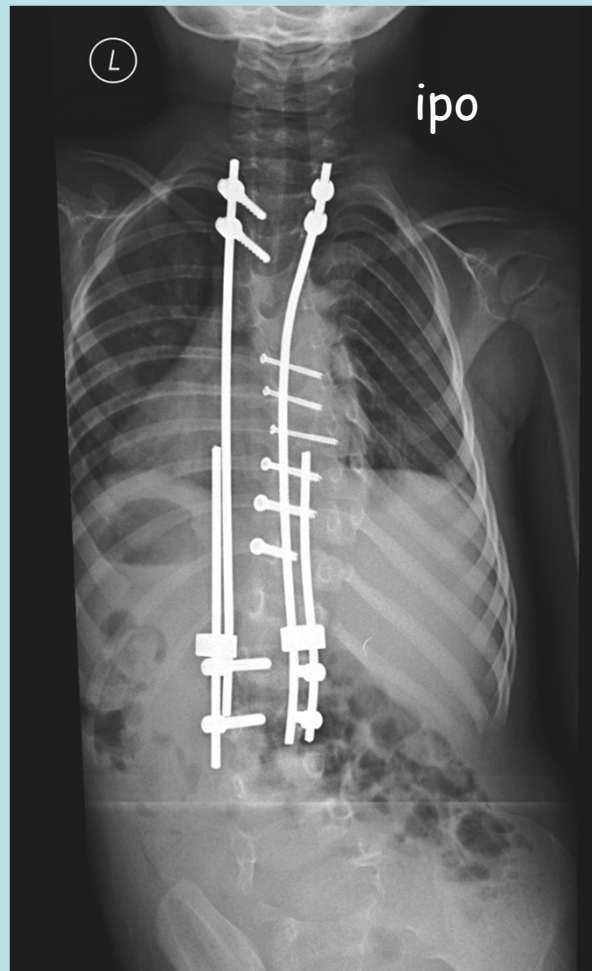
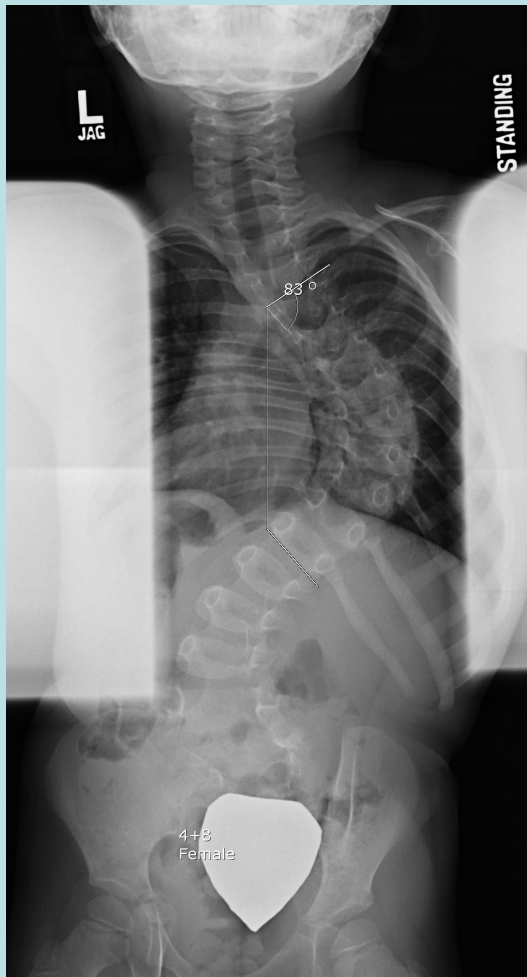
- ? Mechanism of rapid curve development but then no further worsening
- ? mechanism of more effective modulation at older age with established deformity

ipo 2 w 4 w 6 w ipo #2 10 w 17 wk



Clinical Application

- 4+8 yo fem with lipomeningocoele

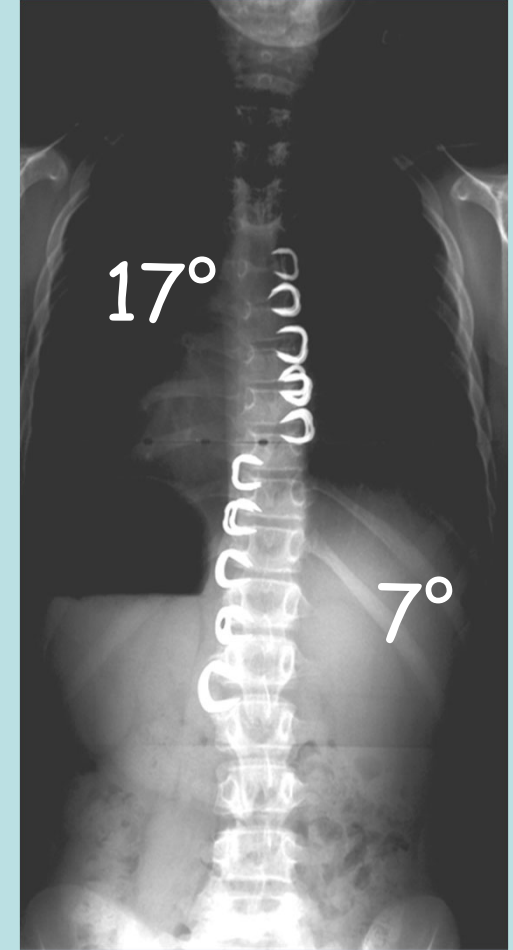
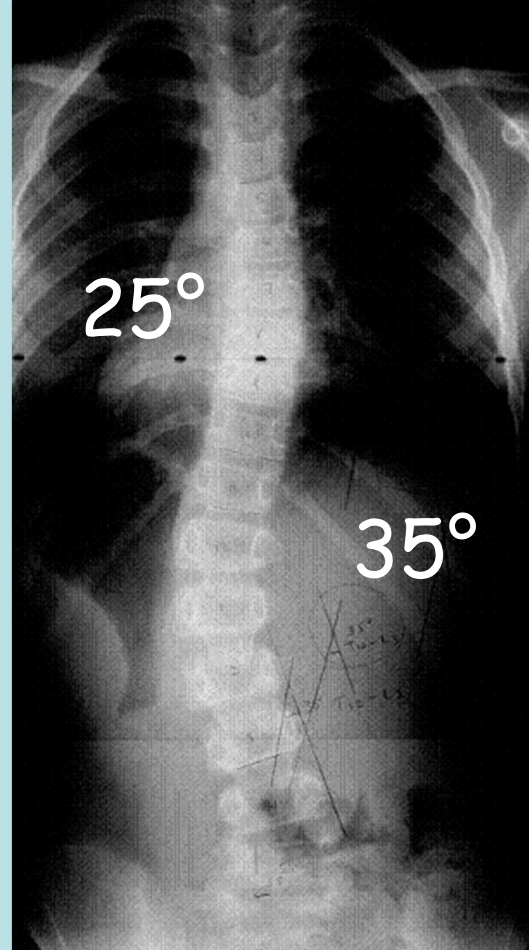


Clinical - Vertebral Stapling (Betz et al '05, paper #17 SRS '08)

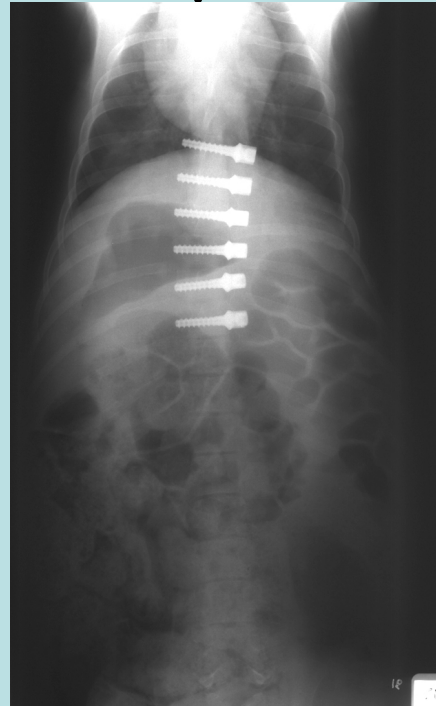
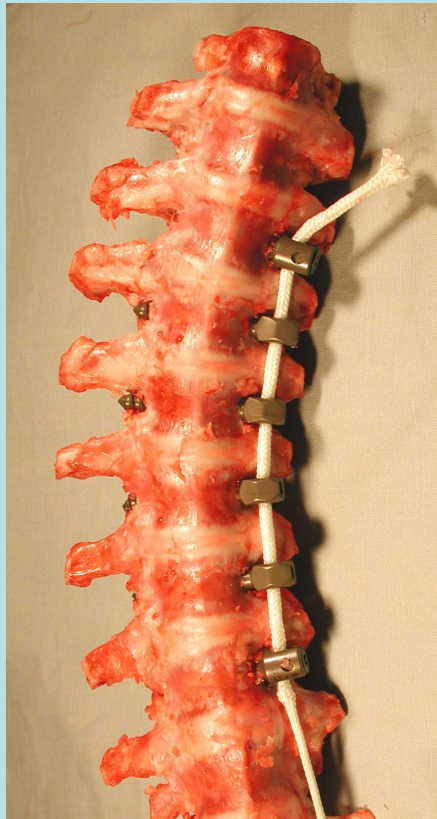


Applicable to smaller
curves

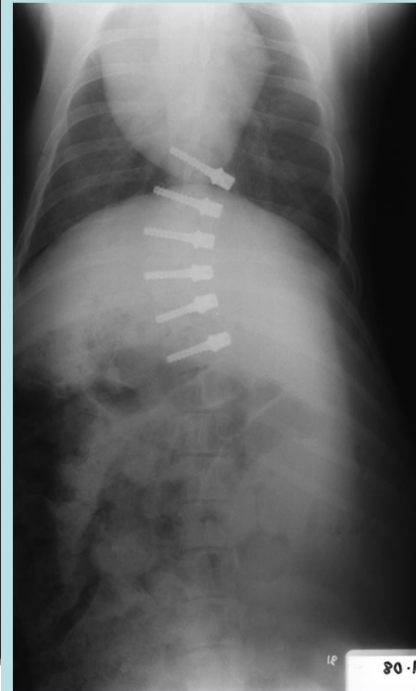
? Ineffective in larger
curves or fixed concave
"tether" (e.g. Braun)



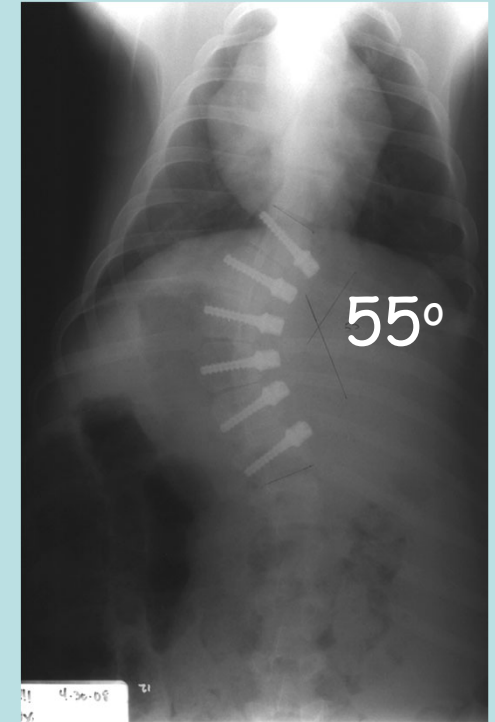
Screw + cable - increased moment arm
(vs. staple or NCS screw) to produce
asymmetric tether



1 mo



3 mo

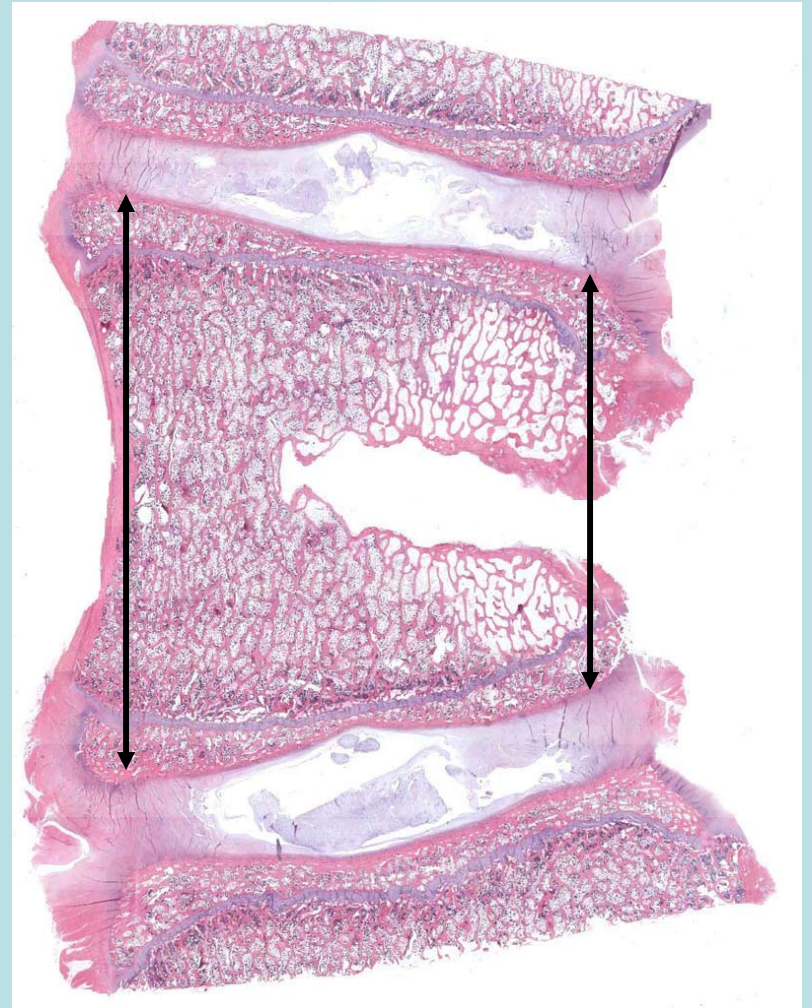


6 mo

Deformity evenly distributed
among several segments
(note screw obliquity)

Vertebral wedging by asymmetric compression (heuter-volkman)

(see Newton et al, Spine '08)



Where do we stand?

- Current techniques (serial “re-correction”) have major drawbacks ...not as fusionless as originally hoped
[auto-lengthening devices (e.g. Phenix M. rod) → still pure distraction]
- Modulation methods - preserve function
 - flexible tethers
 - NCS screws
 - rib/chest wall manipulation (re-discover) ★

COMING SOON ?