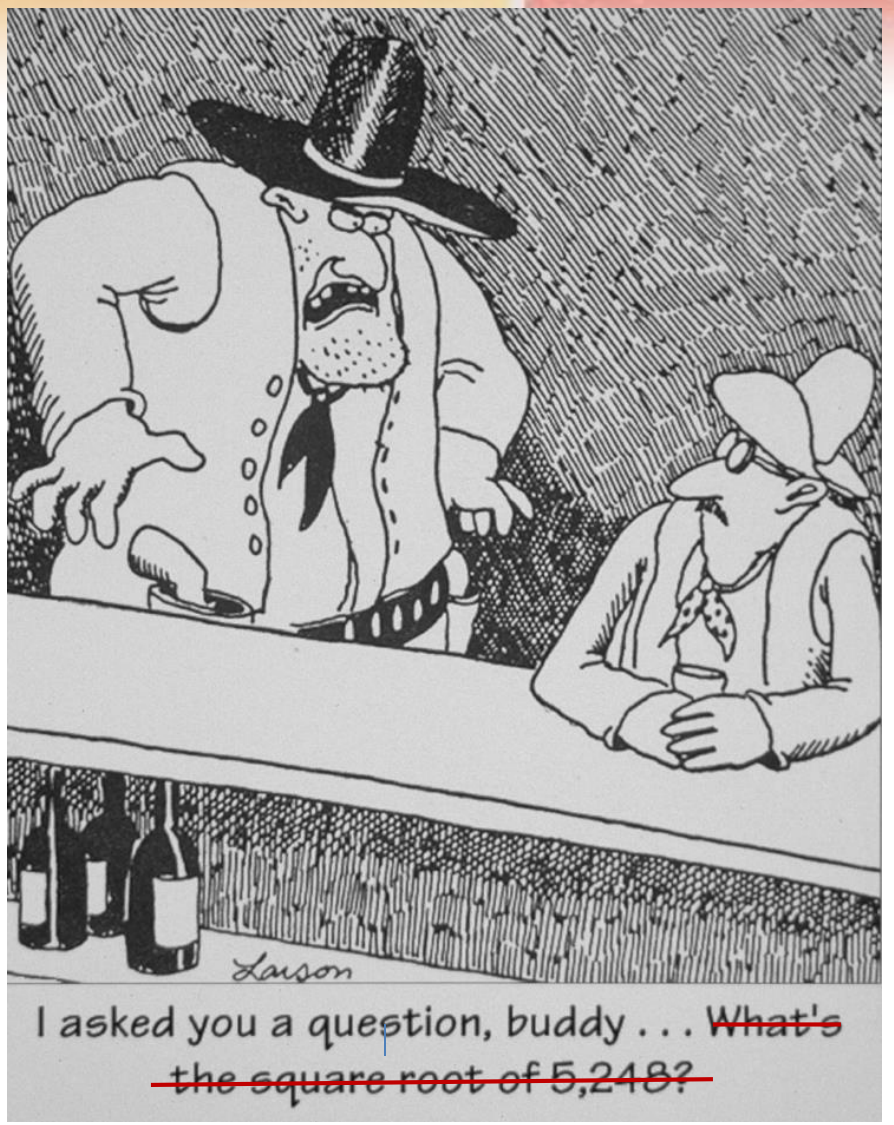

Why Do We Need To Really Drive Growth ?

ICEOS 2018 Lisbon

Charles E Johnston MD

Disclosures: Medtronic, Elsevier

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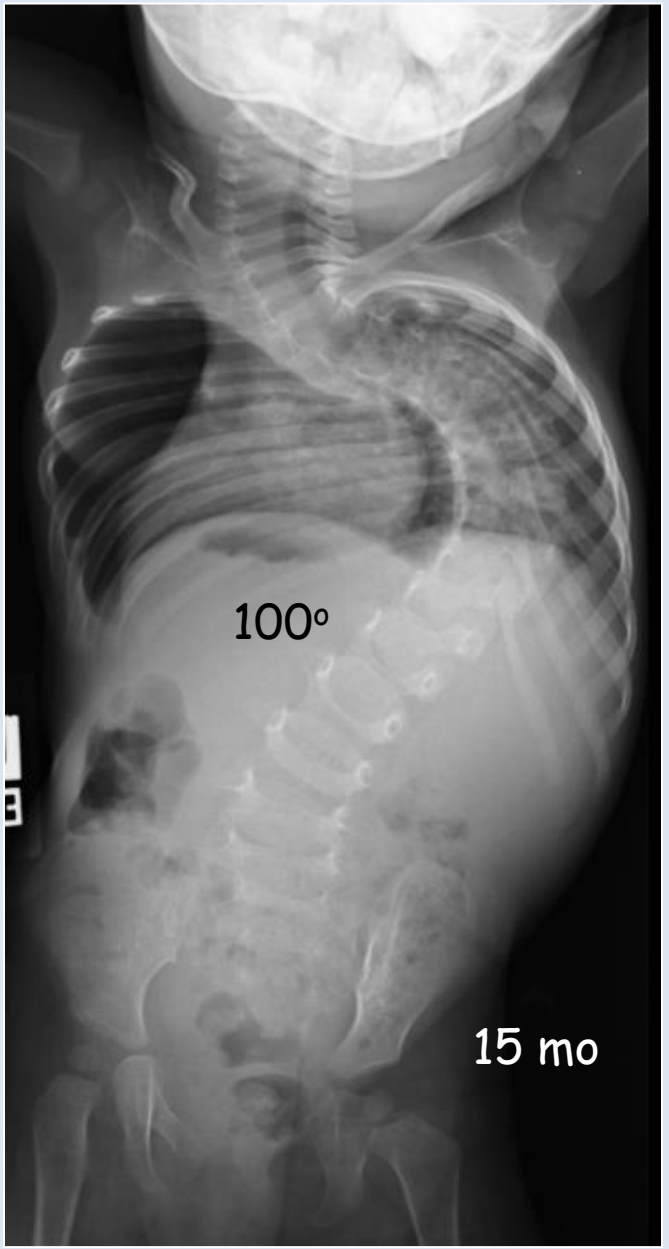
Questions to ask

- Spine deformity vs chest wall deformity …or both
- Natural Hx ?
- Treat now or can we delay / how bad IS it ?
- Intrinsic growth possible, can we harness it… or <u>do WE have to grow it ?</u>



Classification

Development and Initial Validation of the Classification of Early-Onset Scoliosis (C-EOS)

Brendan A. Williams, MD, Hiroko Matsumoto, MA, Daren J. McCalla, BS, Behrooz A. Akbarnia, MD, Laurel C. Blakemore, MD, Randal R. Betz, MD, John M. Flynn, MD, Charles E. Johnston, MD, Richard E. McCarthy, MD, David P. Roye Jr., MD, David L. Skaggs, MD, John T. Smith, MD, Brian D. Snyder, MD, PhD, Paul D. Sponseller, MD, MBA, Peter F. Sturm, MD, George H. Thompson, MD, Muharrem Yazici, MD, and Michael G. Vitale, MD, MPH

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- Outcome Data Needed to confirm value of C-EOS

Age	Etiology	Major Curve Angle	Kyphosis	APR Modifier
Continuous Prefix	Congenital/ Structural	1: <20°	(-): <20°	P0: <10°/yr
	neuroMuscular	2: 20-50°	N: 20-50°	P1: 10-20°/yr
	Syndromic	3: 51-90°		
	Idiopathic	4: >90°	(+): >50°	P2: >20°/yr

4+ =Trouble

1. Age 20 mo.
2. Growth potential poor
3. Growing construct compromised by sagittal plane

My Concerns – if growth needed

- Merely keeping up with "normal" growth rate will not move the needle toward ↑'d PFT
- Maximum distraction lengthening with TGR at best **just keeps up** with a "normal" growth rate -> not moving the needle
- MCGR, rib-based constructs do not currently produce enough length to even "keep up"
- Certain dx's (e.g. congenital, syndromic) resistant to standard lengthening
  -> more distractive force, more often
- Caution: may produce more stiffness and early auto-ankylosis

Distraction-based Rx and The 18cm hurdle

El—Hawary et GSSG,CSSG

135 pts. / mean lengthen 11

Final Th Ht > 18 cm **65%**

> 22 cm 30%

<u>>18cm</u>

Congen	**48%**
N-m	80%
Syndr	86%
JIS/IIS	**68%**

Pulmonary Function Following Early Thoracic Fusion in Non-Neuromuscular Scoliosis

By Lori A. Karol, MD, Charles Johnston, MD, Kiril Mladenov, MD, Peter Schochet, MD, Patricia Walters, RRT-NPS, and Richard H. Browne, PhD

Investigation performed at the Department of Orthopaedic Surgery, Texas Scottish Rite Hospital for Children, Dallas, and the Department of Pulmonology, Children's Medical Center of Dallas, Dallas, Texas

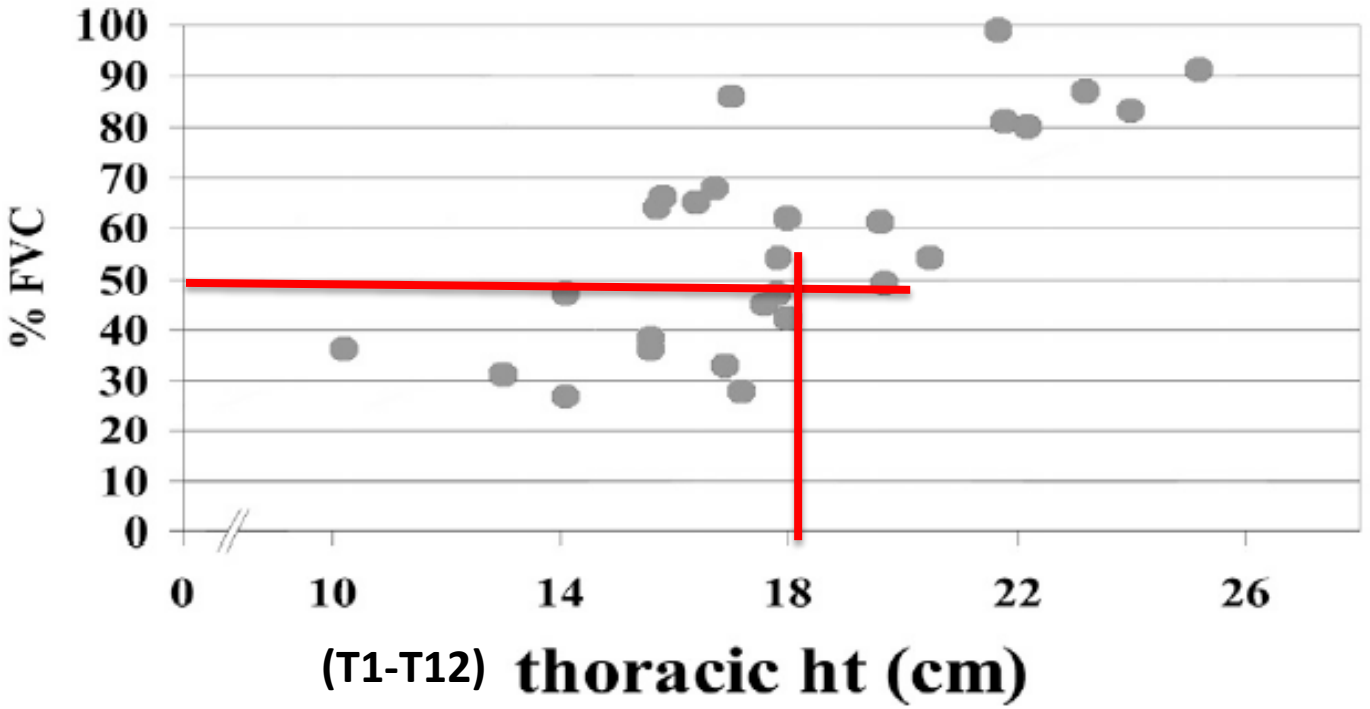
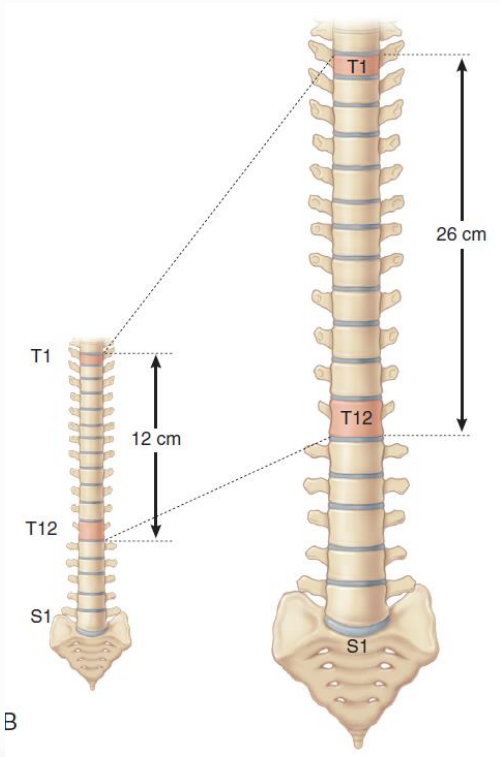


Fig. 3

The thoracic height at the time of follow-up versus the percentage of predicted forced vital capacity (FVC). Patients with the shortest thoracic spinal height (measured from T1 to T12) had the greatest restriction of pulmonary volume ($r = 0.73$, $p < 0.001$).

Minimal correction
Congenital dx's
Large residual curves
(in situ rx)



Limitations of Distraction-based RX

- MCGR -> ineffective lengthening w/ "standard" protocols

Eur Spine J (2016) 25:3371–3376
DOI 10.1007/s00586-015-4223-4

ORIGINAL ARTICLE

Radiological and clinical assessment of the distraction achieved with remotely expandable growing rods in early onset scoliosis

D. Rolton[1] · C. Thakar[1] · J. Wilson-MacDonald[1] · C. Nnadi[1]

TD = true (actual) distraction
ID = intended distraction
TD/ID = 0.33
0.30 conversions
0.35 1^0 implantation

THE BONE & JOINT JOURNAL

■ SPINE

Quantifying the 'law of diminishing returns' in magnetically controlled growing rods

papers # 21 & 22

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A. Ahmad,
T. Subramanian,
P. Panteliadis,
J. Wilson-Macdonald,
D A. Rothenfluh,
C. Nnadi

"...as the age, weight or BMI increases, the percentage of intended concave rod distraction decreases significantly by two years."

"Despite the decrease in the mean T/I ratio over time, the mean ***T1-S1 length*** increased from **222** mm to **243** mm at ***final follow-up*** and had no consistent drops."

Underwhelming ?!

Let's Compare… TGR

- GR Graduates/TSRH JBJS-A 99:1037,2017 n=12 mult dx's

TABLE III Radiographic Outcomes*

	Preop.	Postop.†	Most Recent F/u
Age *(yr)*	5.0 (1.3–7.9	11.0 (7.4–13.1)	13.8 (9.8–17.0
Curve *(°)*	88 (25–123)	48 (19–83)	47 (16–83)
T1–T12 *(cm)*	13.3 (8.4–17.7)	20.9 (9.8–29.5)	22.3 (9.7–32.9)
T1–S1 *(cm)*	22.3 (12.4–27.8)	33.4 (17.0–46.6)	34.7 (17.7–43.8)

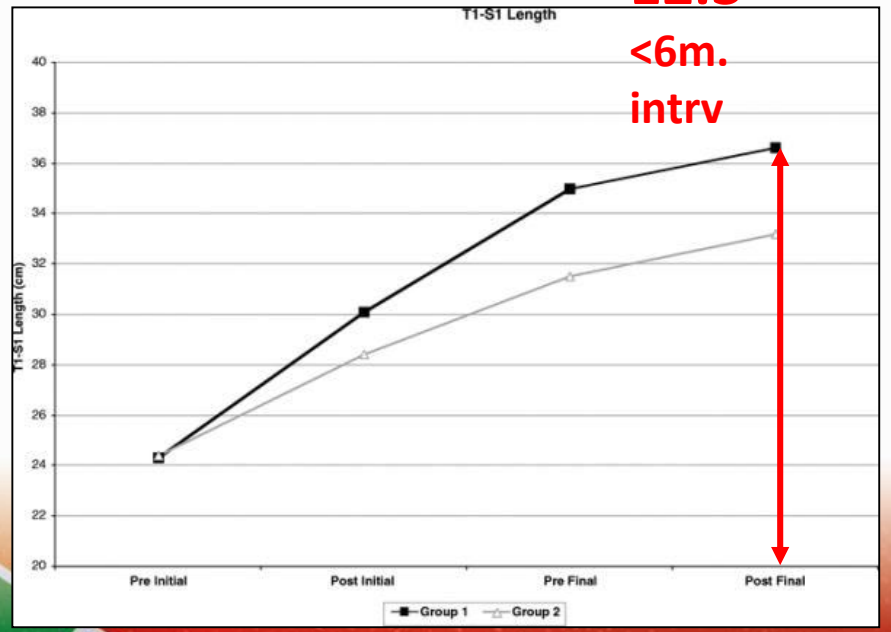
- Akbarnia 3-11 yr f/u dual GR Spine 2008
  n=13 non-cong all final fusion

T1–S1 cm	24.4 ± 3.4	29.3 ± 3.6 (ipo)	35.0 ± 3.7

T1-12 = 9 cm

12.3

<6m. intrv



NO COMPARISON …

- TGR's -> 12+ cm T1-S1 length - final
- MCGR's -> **2 cm** T1-S1 length - 51 mo, decreasing 2/2 LODRs

Magnetically controlled Growing Rods for Early-onset Scoliosis Spine 41:1456,2016

A Multicenter Study of 23 Cases With Minimum 2 years Follow-up

Pooria Hosseini, MD, MSc,* Jeff Pawelek, BS,* Gregory M. Mundis, MD,* Burt Yaszay, MD,† John Ferguson, MD,‡ Ilkka Helenius, MD,§ Kenneth M. Cheung, MD,¶ Gokhan Demirkiran, MD,‖ Ahmet Alanay, MD,** Alpaslan Senkoylu, MD,†† Hazem Elsebaie, MD,‡‡ and Behrooz A. Akbarnia, MD*

23 pts. / 15 centers non-US
15 primary, 8 conversions

Conversion Cases - actually *shortened* over 2 yr f/u period

270mm @ baseline
294mm ipo
290mm @ 2 yr

Underpowered magic

PFT Summary – GR "graduates"

Johnston, JBJS 99-A:1036,2017

- FEV1 abs vol ↑ 900 cm^3 (200-1200)
- FVC abs vol ↑ 1100 cm^3 (100-1800)

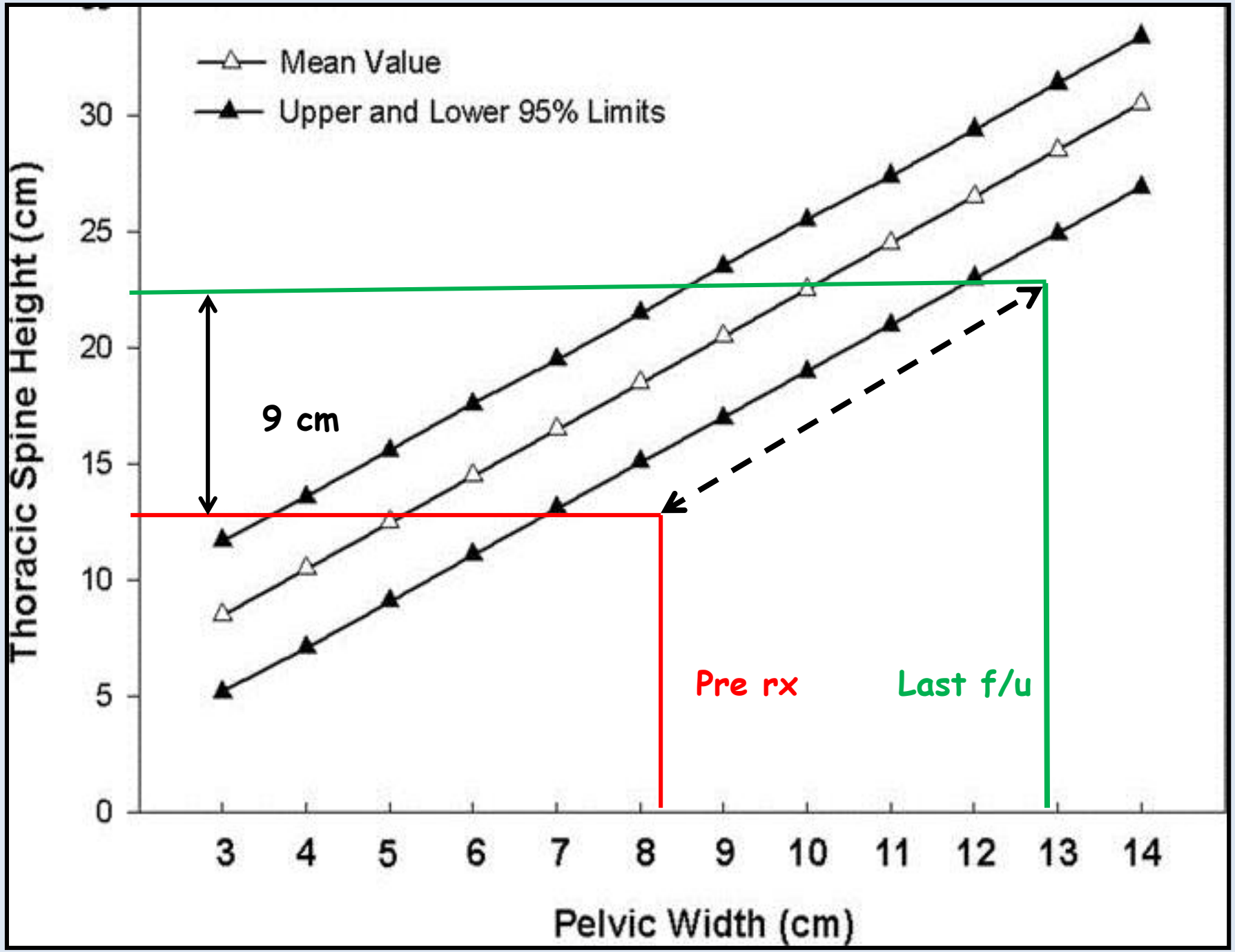
- FEV1 %pred ↓ 1.7 % (52.1%)
- FVC %pred ↑ 1.8% (55.3%)

= no change

- Deformity corrected 88° -> 47° mean
- over 6.7 yr f/u (5-11 yr)

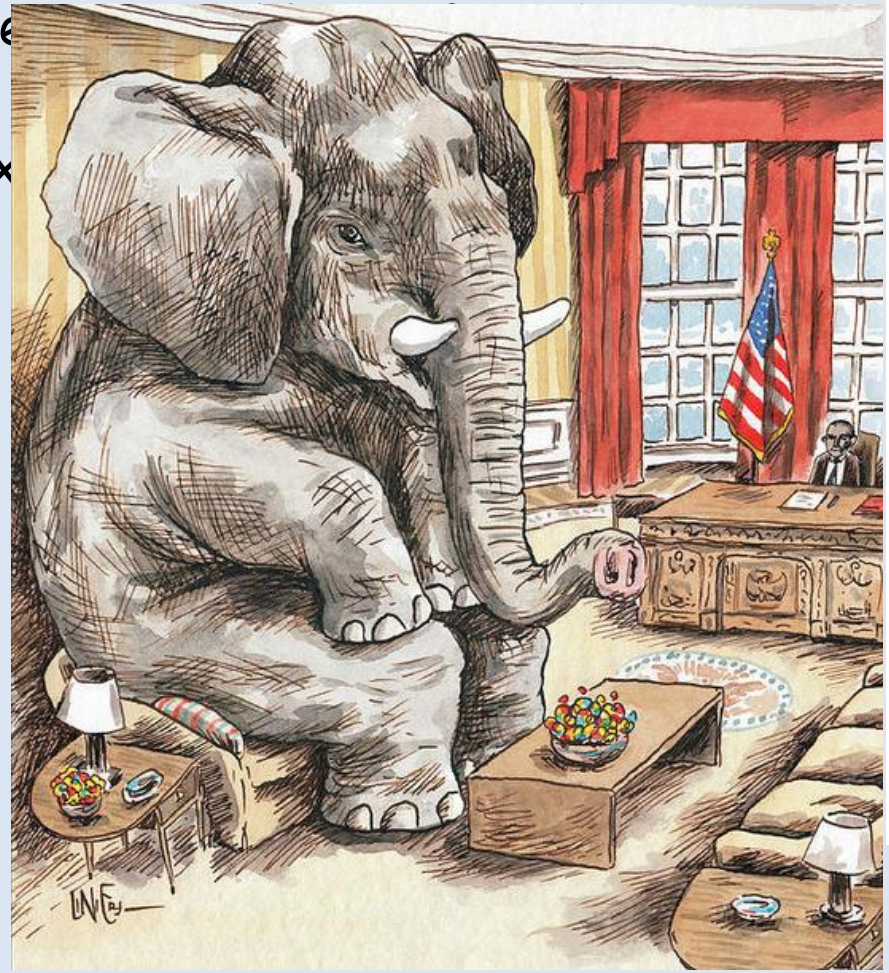
TGR

Normalized for pelvic width



GR vs Veptr for idiopathic EOS

- 50 GR's (age 5.5y), 22 Veptrs (4.3)
  p=.04
- Procedure
  p<.001
- Wound cx
  p=.011



Rib-Based Less effective

Sponseller et al (GSSG,CSSG) Prague SRS 2016

Time Point	Radiographic Parameter	GRs	VEPTRs	p-Value
PRE-OP	Major curve size (°)	78	74	.388
	T5-T12 thoracic kyphosis (°)	36	31	.319
	Spinal height (mm)	255	237	.062
	Thoracic height (mm)	153	145	.397
POST-OP	Major curve correction (%)	50.0	27.3	**<.001**
	T5-T12 thoracic kyphosis (°)	19	22	.549
	Spinal height (% gain)	17.2	11.6	.737
	Thoracic height (% gain)	18.0	18.3	.651
LENGTHENING PERIOD *(POST-OP TO MOST RECENT)*	Loss of index curve correction (%)	14.2	20.2	.629
	Spinal height (% gain)	18.5	15.5	.281
	Thoracic height (% gain)	24.2	11.6	**.024**
OVERALL *(PRE-INDEX TO MOST RECENT)*	Major curve correction (%)	43.4	16.7	**<.001**
	T5-T12 thoracic kyphosis (°)	35	49	**.018**
	Spinal height (% gain)	34.8	34.2	.885
	Thoracic height (% gain)	45.0	30.4	.199

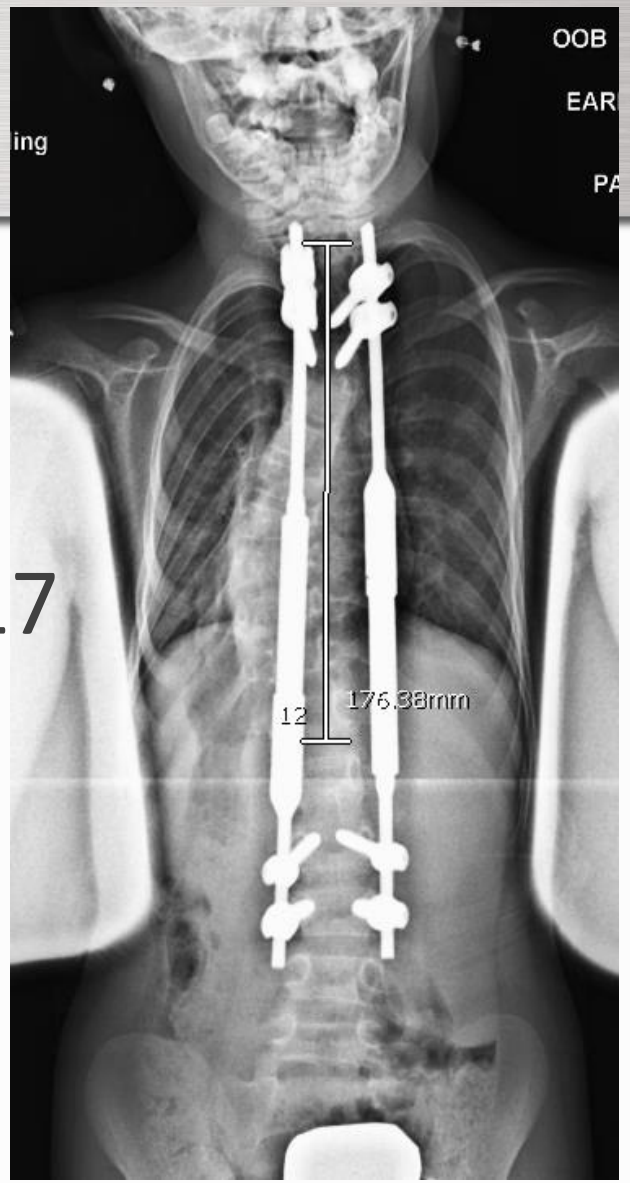
Start @ 12cm -> hard pressed to reach 18cm

Lengthening Equation (annual) RCT

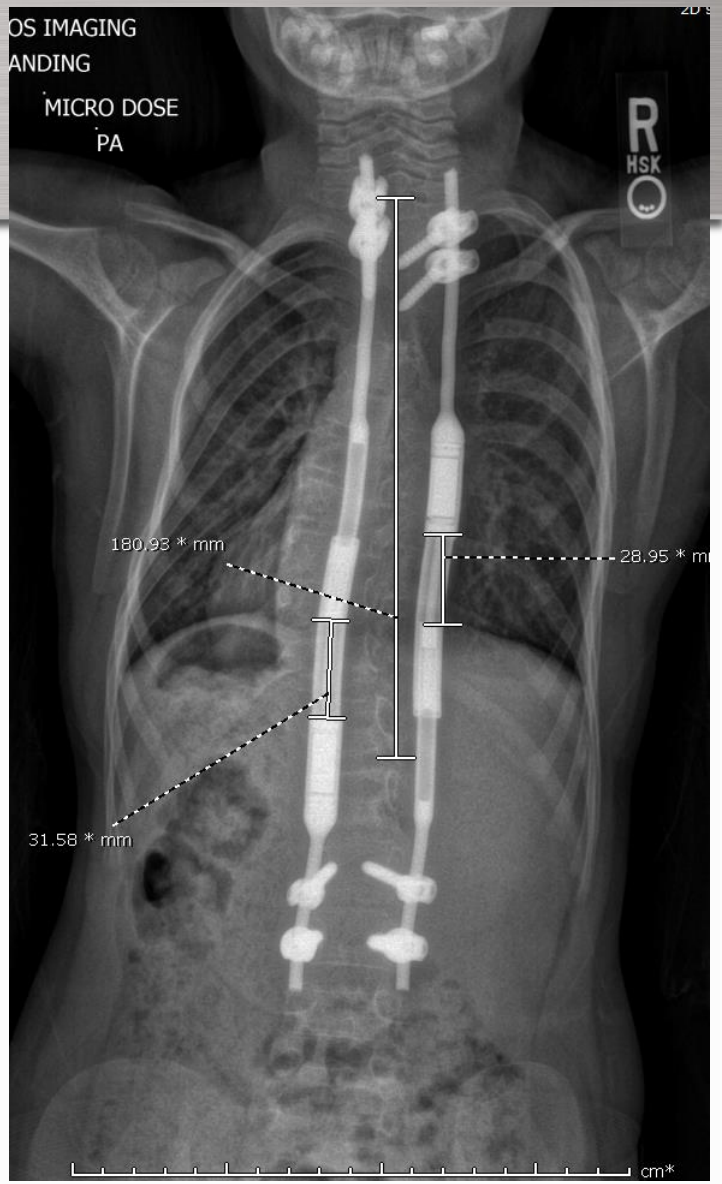
$$\frac{1.25 \text{ X } \#\text{ instr vert X } 22 \text{ mm}}{17}$$

- (1.25 x 13 vert. x 22 mm) / 17
  = **21.0 mm/yr**

- If 6 week group: 21.0 / 8.66
  = **2.42 mm/visit**
- If 16 week group: 21.0 / 3.25
  = **6.46 mm/visit**



Age 5 7/14 ipo T1-12= **17.6**
4mm X 3/yr = **36** mm
intended



Age 8 7/17 T1-12 = **18.1**
MCGR length **32** mm L **29** mm R
actual

Conclusions

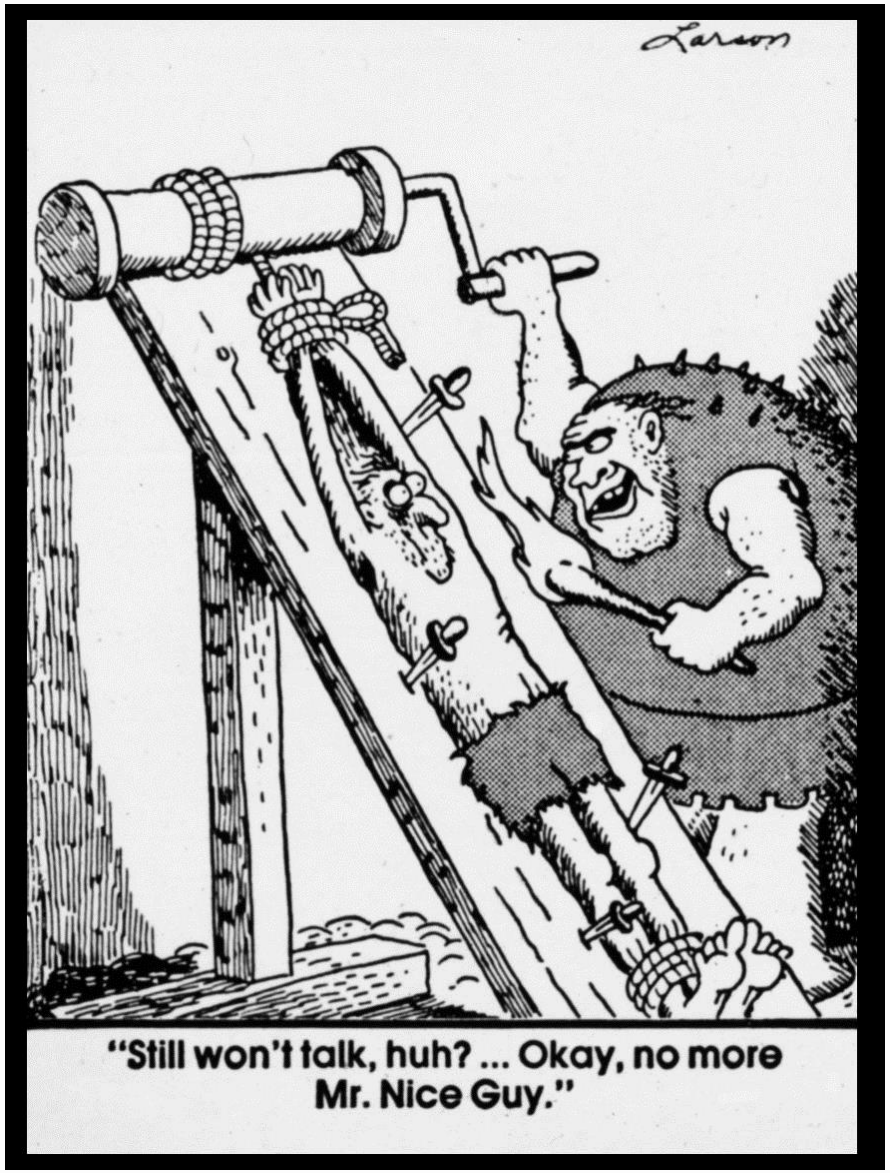
- If we truly need to drive growth (2° inherent growth inhibition).....

→ Previous distraction protocol with TGR just <u>maintains</u> initial %ile, PFT's

- Mcgr limitations → insufficient spine length to be expected ?

- Lengthen to MAX - ? Best technique TBD

Anchors, ankylosis, j.k.'s



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Thanks