

Advances In The Treatment Of Early Onset Scoliosis

Robert H. Cho, MD

Chief of Staff

Shriners Hospital For Children

Los Angeles



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Disclosures

▶ Robert H. Cho:

- Medtronic Sofamor Danek (consultant)
- DePuy Synthes Spine (consultant)
- OrthoPediatrics (consultant)
- NuVasive (consultant)
- Ergobaby (medical advisory board)
- *Orthopedics Journal* (reviewer)



Introduction

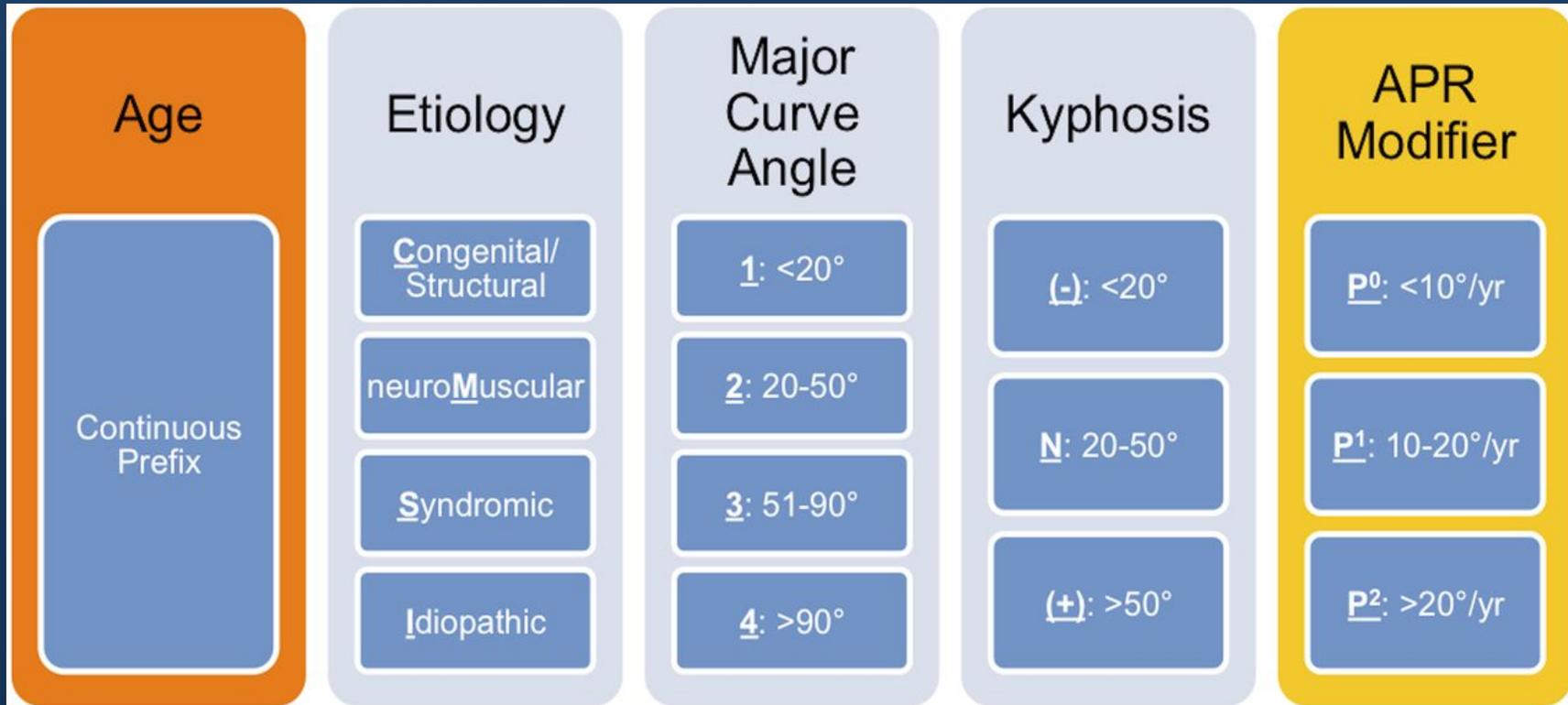
History

- ▶ **Early Onset Scoliosis remains quite challenging to treat**
- ▶ **Many different etiologies**
 - Infantile idiopathic
 - Juvenile idiopathic
 - Congenital
 - Neuromuscular
 - Syndromic



Classification

The Classification of Early-Onset Scoliosis (C-EOS).



Williams B A et al. J Bone Joint Surg Am 2014;96:1359-1367



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Classification

The Classification of Early-Onset Scoliosis (C-EOS).

▶ Why is it important

- Need to speak the same language
- Improve treatment paradigms
- Better tailor research to specific EOS types

▶ Important takeaway points

- Type, age, curve magnitude, presence of kyphosis, and amount of progression matter in decision making
- What works for one type does not necessarily work for another



Congenital Scoliosis

Treatment

- ▶ Casting – probably not effective
- ▶ In situ fusion
- ▶ Convex hemiepiphysodesis
- ▶ Hemivertebra excision
- ▶ Growth Modulation



Treatment Strategies

For Non-Congenital EOS

▶ Non-surgical

- Observation
- Bracing
- Casting

▶ Surgical

- Growth Friendly Constructs (younger patients)
 - VEPTR
 - Hybrid/Mongrel
 - MAGEC
 - SHILLA
- Growth Modulation (older patients)
 - Vertebral stapling
 - Vertebral tethering
- Spinal Fusion



Bracing in Early Onset Scoliosis

- ▶ Not a lot of published literature
- ▶ What is published has poor power or study design
- ▶ Prospective studies being concurrently run through multiple study groups to evaluate versus casting



Cotrel-Mehta Body Casting

- ▶ Still the gold standard for infantile idiopathic scoliosis



Casting and Traction Treatment Methods for Scoliosis

Jacques L. D'Astous, MD, FRCS(C)^{a,b,*}, James O. Sanders, MD^c

^aDepartment of Orthopaedic Surgery, University of Utah Orthopaedic Center, 590 Wakara Way,
Salt Lake City, UT 84108, USA

^bShriners Hospitals for Children - Intermountain, Fairfax Road & Virginia Street,
Salt Lake City, UT 84103, USA

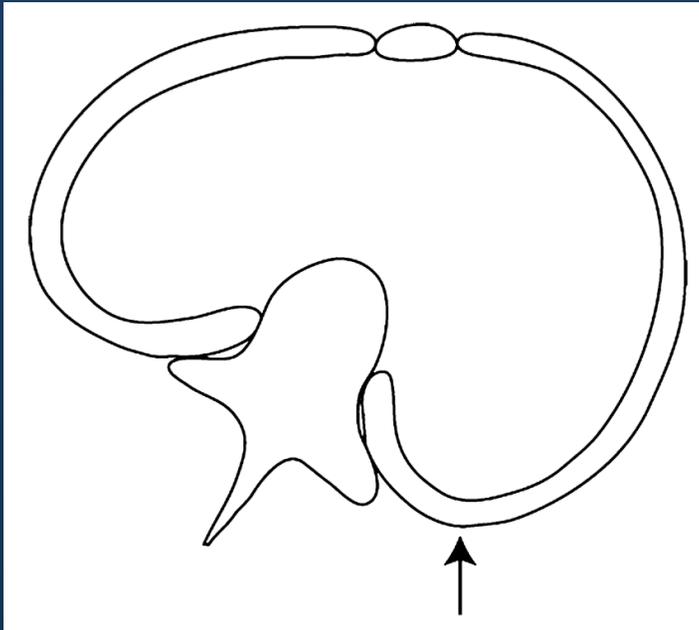
^cShriners Hospitals for Children, 1645 West 8th Street, Erie, PA 16505, USA



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Cotrel-Mehta Body Casting

- ▶ Still the gold standard for infantile idiopathic scoliosis



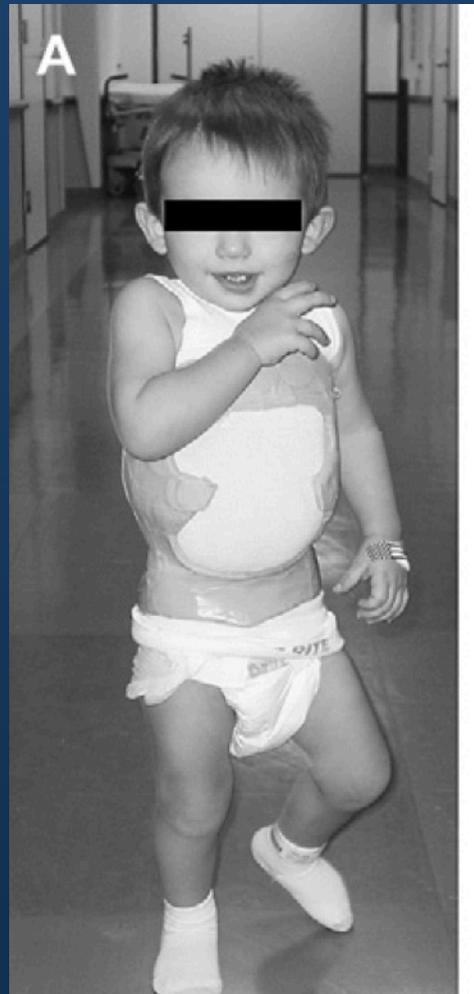
Key: Mold that incorporates
DEROTATION



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Infantile Idiopathic Scoliosis

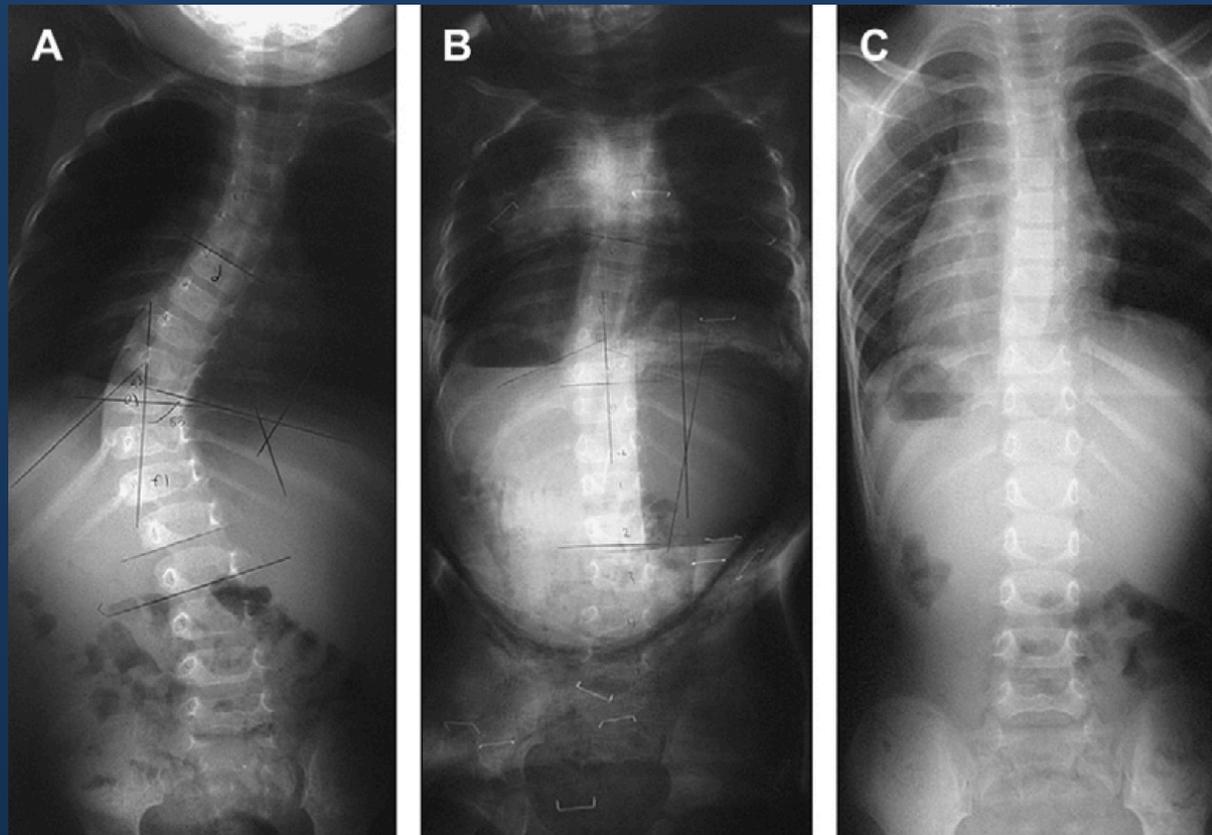
Body Casting



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Infantile Idiopathic Scoliosis

Body Casting

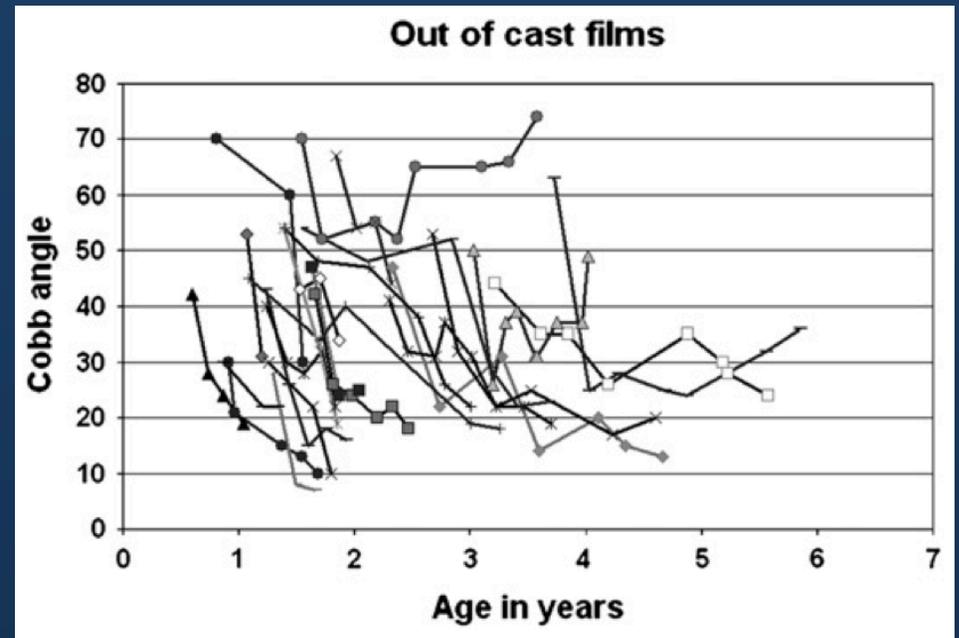


Infantile Idiopathic Scoliosis

Body Casting

▶ Results

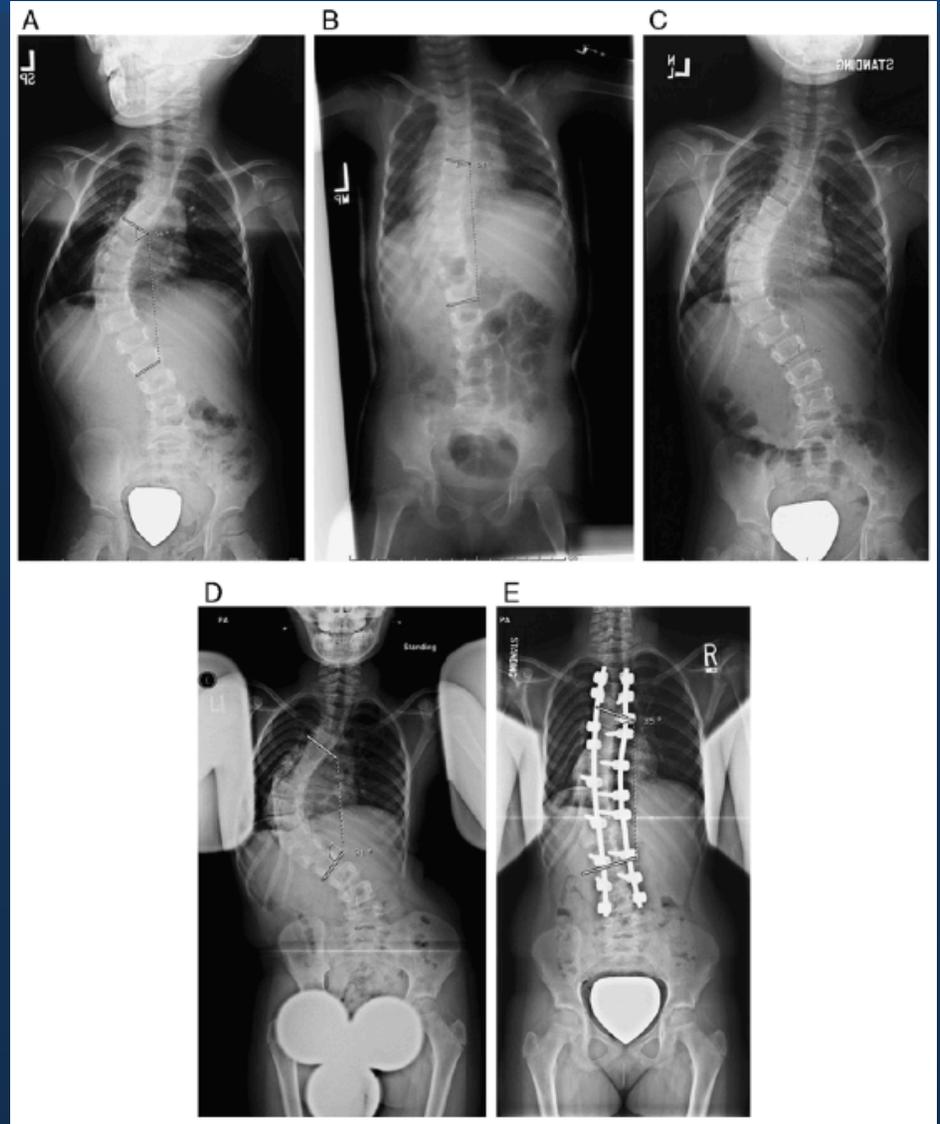
- Initiation of casting less than 2 years of age usually improves curve dramatically
- Results fall off after initiation of casting after 2 years of age



Body Casting

What about failures?

- ▶ **Fletcher et. al JPO 2012**
 - Use as a delay tactic for eventual surgery
- ▶ **Don't necessarily think of it as a failure!**



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Growth Friendly Constructs

VEPTR device

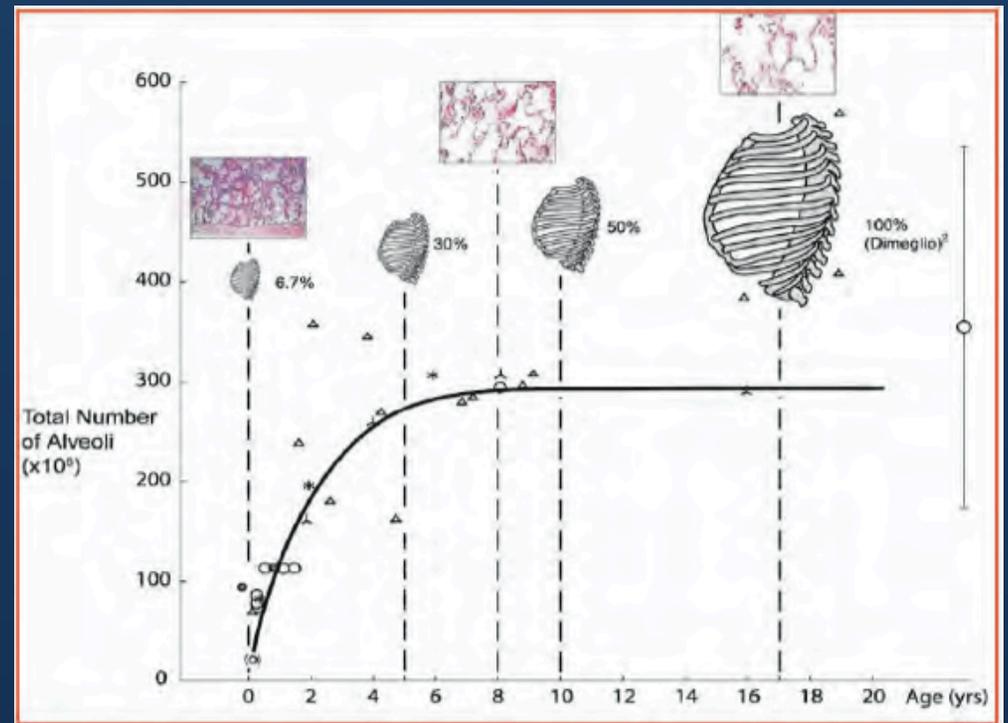
- ▶ **Original FDA clearance through Humanitarian Device Exemption**
- ▶ **Recently FDA cleared through 510(k) pathway**
- ▶ **Indication: Thoracic insufficiency syndrome**
 - Inability for the thorax to support normal respiration or lung growth
 - Off label uses abound



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Growth Friendly Constructs

VEPTR device



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Growth Friendly Constructs

VEPTR device

- ▶ **Pros:** rib based anchors, can modulate thoracic growth, can modulate spine growth
- ▶ **Cons:** stiffens the thoracic cavity, can cause autofusions across uninstrumented areas, \$\$\$, need to mix and match to pedicle screws (6.0 cm diameter), large implant profile



Growth Friendly Constructs

Hybrid/Mongrel Constructs

- ▶ Growing rods that incorporate rib based hooks cephalad and pedicle screws distally
- ▶ Probably safer and “sloppier” than spine-to-spine growing rods



Growth Friendly Constructs

Hybrid/Mongrel Constructs

▶ Why safer?

- Implant pull-out through ribs, not into spinal canal
- Less stable proximal anchor, thus allowing some movement in spanned spinal segment = less autofusions

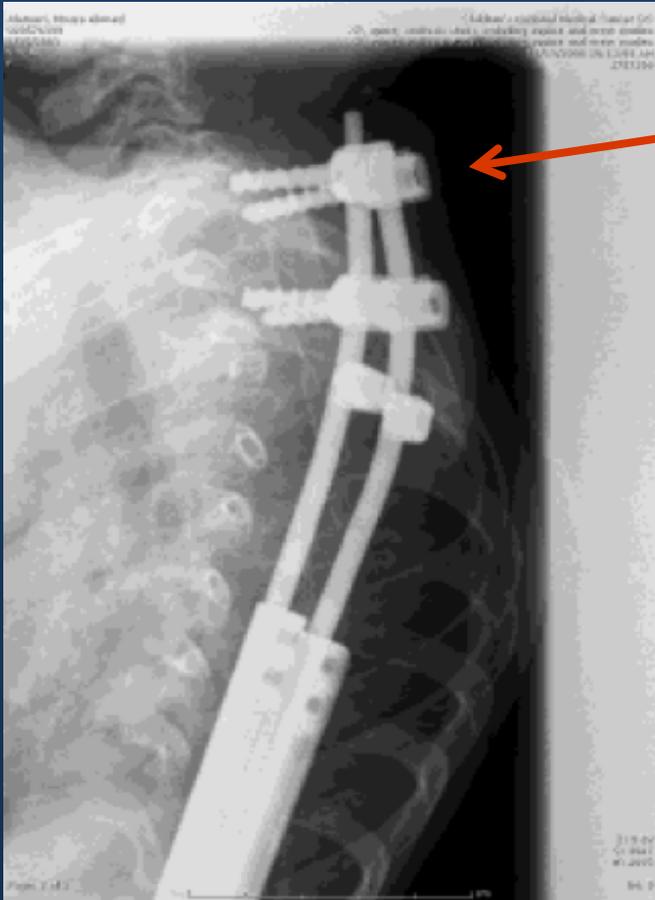
▶ Sankar et al. Spine 2010

- VEPTR: 2.3 complications/patient
- Standard GR: 2.3 complications/patient
- Hybrid GR: 0.9 complications/patient

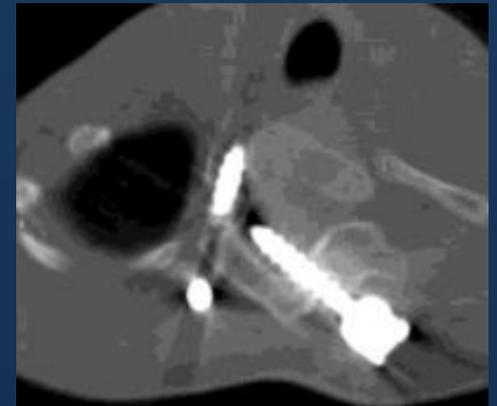
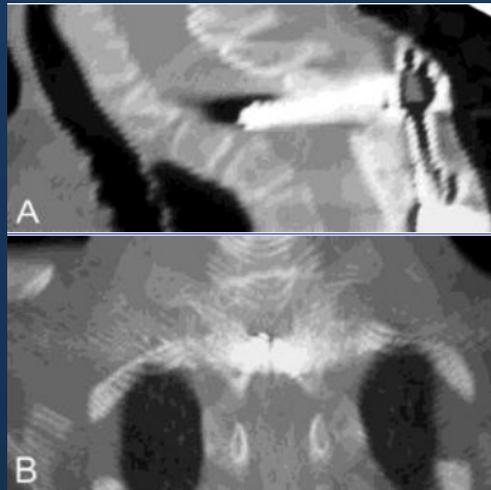


Growth Friendly Constructs

Hybrid/Mongrel Constructs



Possible disaster – especially if screws violate spinal canal!



Growth Friendly Constructs

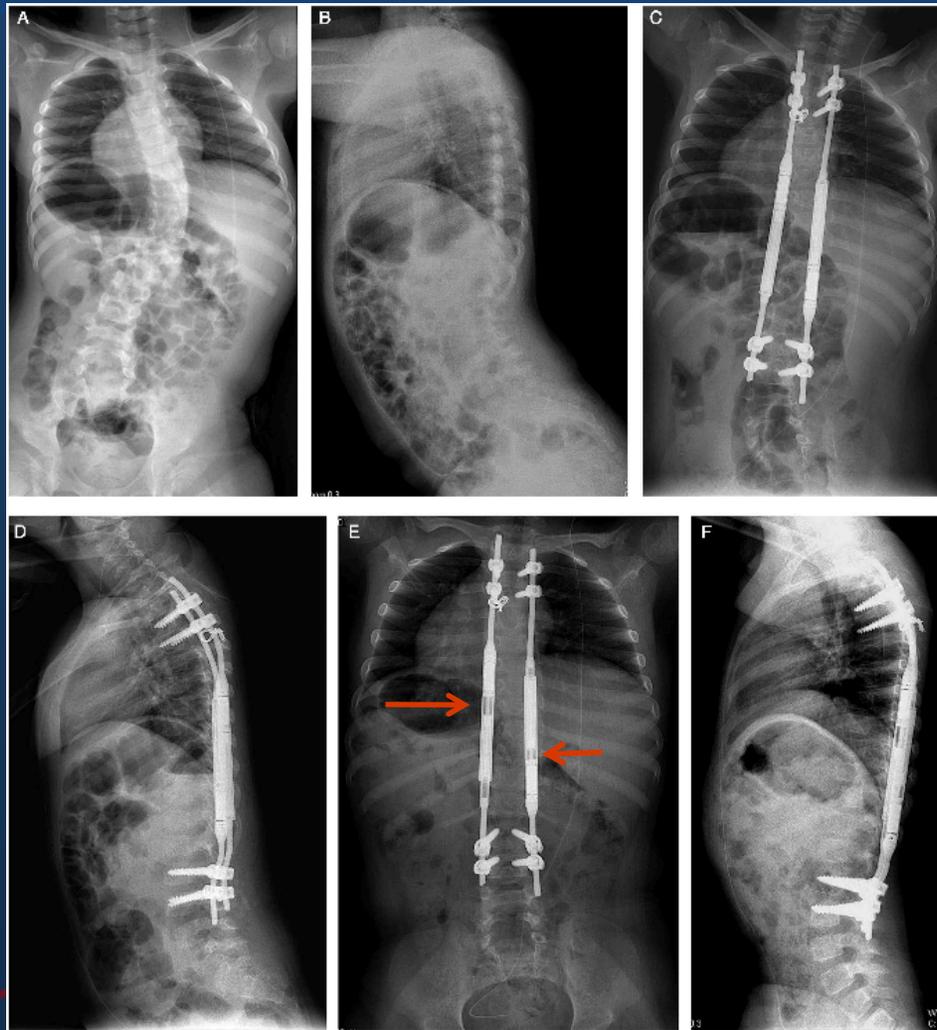
MAGEC Device

- ▶ **Recently FDA 510k cleared (2014)**
- ▶ **Distraction based device**
- ▶ **Utilizes magnetic forces to distract an implanted growing rod across fixed anchors**



Growth Friendly Constructs

MAGEC Device



Display Module

Next Generation MAGEC
External Remote Controller

Growth Friendly Constructs

MAGEC Device

- ▶ **Pros: \$\$\$\$ (OR/hospitalization costs) less surgery for patients, less pain with lengthening in office, increased frequency of lengthening possible**
- ▶ **Cons: \$\$\$\$ (implant cost), unknown long term complications**
- ▶ **Cheung SRS 2014: 44% reoperation rate at 2 years**



Complications

Distraction-based constructs

▶ Bess et al. JBJS 2010

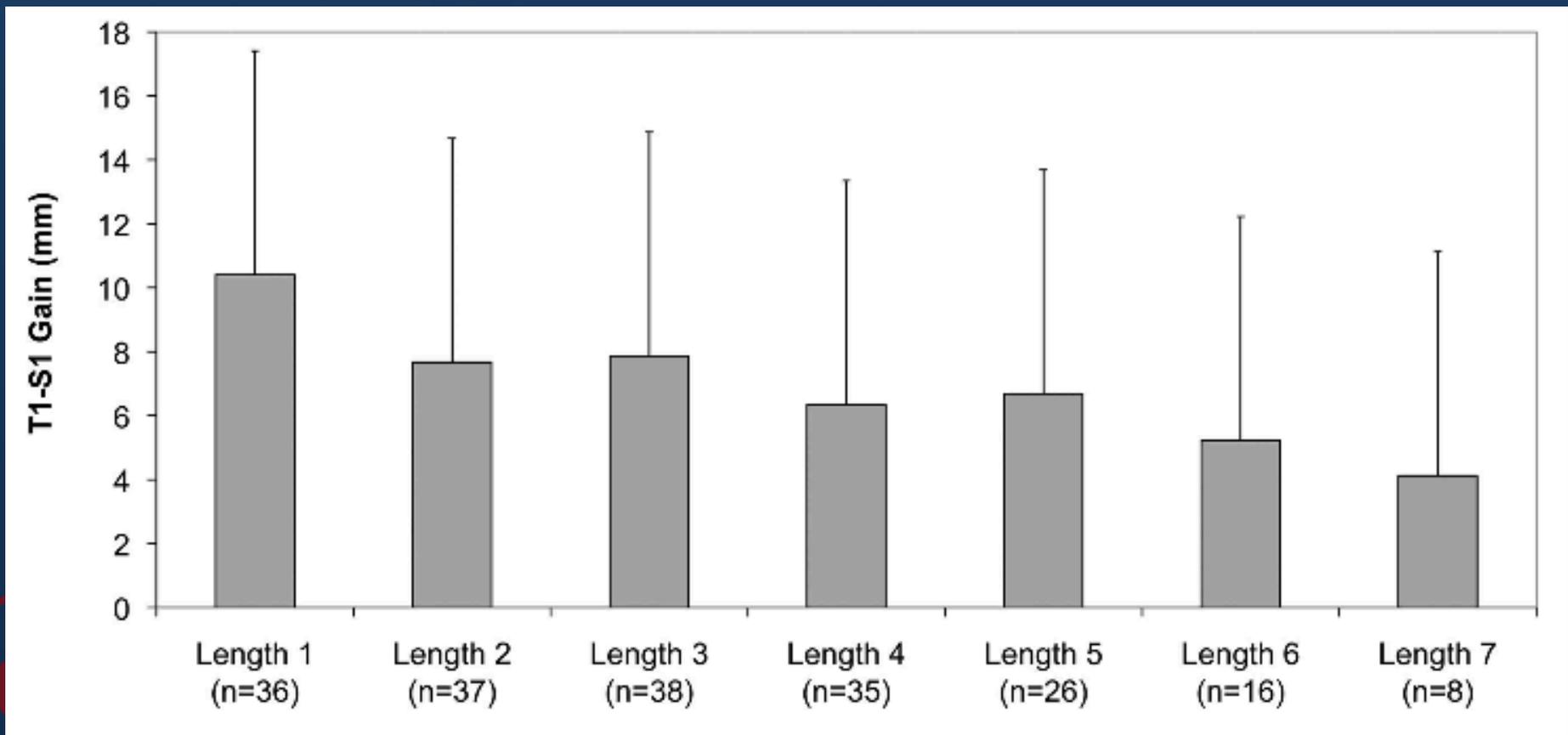
- 140 patients/897 total operations
- 58% of patients had at least 1 complication
- 24% increased risk of complications after EACH operation
- 13% increased risk of complications each year
- Dual rods safer than single rods
- Submuscular implants safer than subcutaneous implants



Complications

Distraction-based constructs

- ▶ **Sankar et al. Spine 2011**
 - Law of diminishing returns



Growth Friendly Constructs

SHILLA Device

- ▶ Developed by Richard McCarthy at the Shilla Hotel in Korea
- ▶ Apical fusion and curve correction
- ▶ Untethered growth cranially and caudally
- ▶ Recently FDA 510k cleared

Locked set screw
(for the apex)



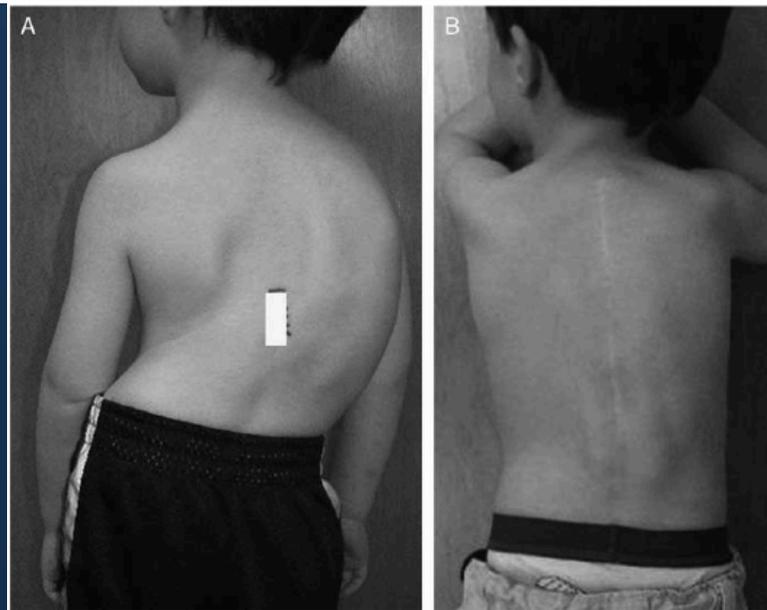
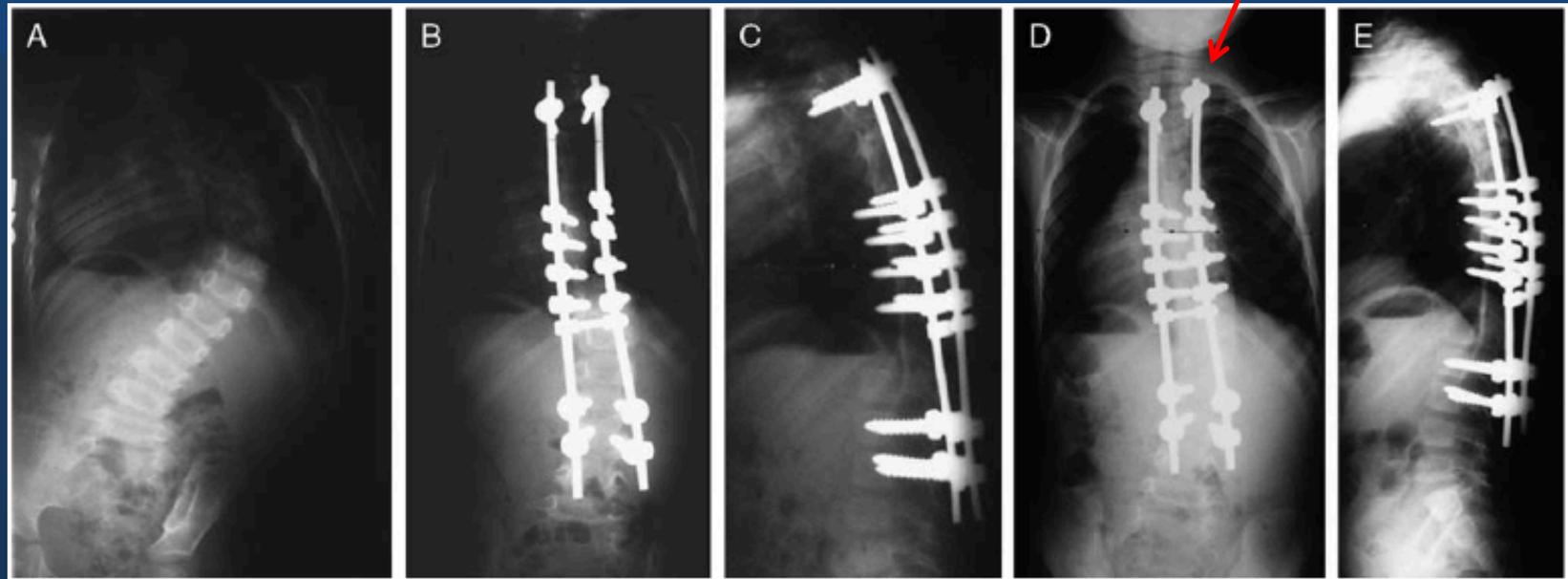
“Floating”
set screw
(for ends)



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Growth Friendly Constructs

SHILLA Device



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Growth Friendly Constructs

SHILLA Device

- ▶ **Pros:** preserves some growth, no distraction = less proximal junctional kyphosis, minimizes return to OR
- ▶ **Cons:** large exposure, must get spine straight at initial surgery to be successful
- ▶ Shilla technique has been around for some time
- ▶ **SHILLA implants are new**



Growth Modulation Constructs

Vertebral Body Stapling

- ▶ Developed in Philadelphia by Dr. Randal Betz as “an internal thoraco-lumbar orthosis”
- ▶ Alternative to bracing



Shape Memory Alloy Staple

NITINOL

Nickel-Titanium-Naval-
Ordnance-Laboratory

- 50% Nickel
50% Titanium
- Improved pullout
- Constant force after implantation

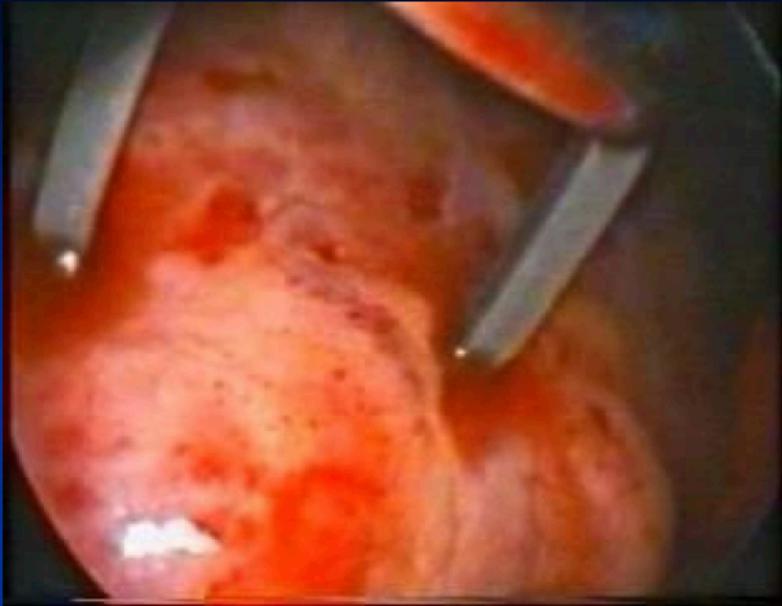


After being in ice bath

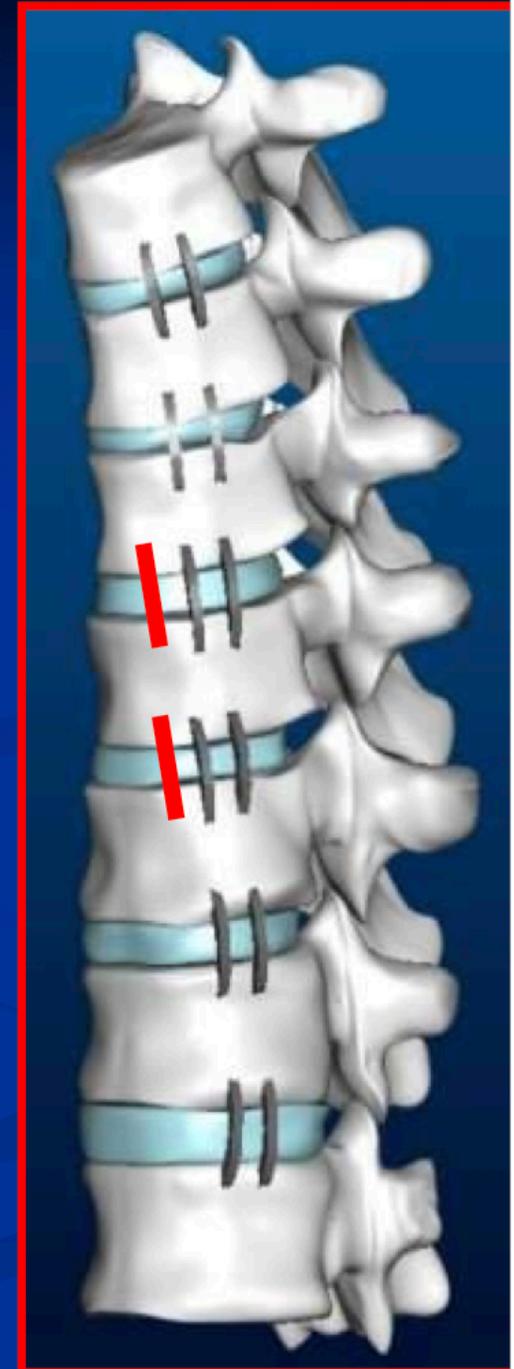


After warming to
body temperature

Courtesy Randal Betz, MD



Video



Staples are FDA 510(k) approved for clinician directed applications in the spine, available through Medtronic

Courtesy Randal Betz, MD

Vertebral Body Stapling

Results

- ▶ **41 curves (29 thoracic, 15 lumbar)**
- ▶ **Average age 9.4**
- ▶ **Success**
 - No change: within 10 degrees of preop Cobb
 - Improved: better than 10 degrees improvement from preop Cobb
- ▶ **Thoracic curves <35 degrees: 79% success rate**
- ▶ **Thoracic curves >35 degrees: 20% success rate**
- ▶ **Lumbar curves: 87% success rate**



Vertebral Body Stapling

Discussion

- ▶ **Indications: skeletally immature patients with less than 35 degrees of coronal curve and not hyperkyphotic**
- ▶ **Can consider adjuncts to growth if exceeding these numbers**



Growth Modulation Constructs

Vertebral Body Tethering

- ▶ Utilizes posterior spinal implants off-label (DYNESIS: Zimmer Warsaw IN)
- ▶ Anterior titanium screws
- ▶ Flexible tether in between screws (polyethylene terephthalate)



Growth Modulation Constructs

Vertebral Body Tethering

▶ Ideal candidate

- Skeletally immature patient (>8 years old)
- High risk of progression
- Curve less than 60 degrees
- Flexible curve

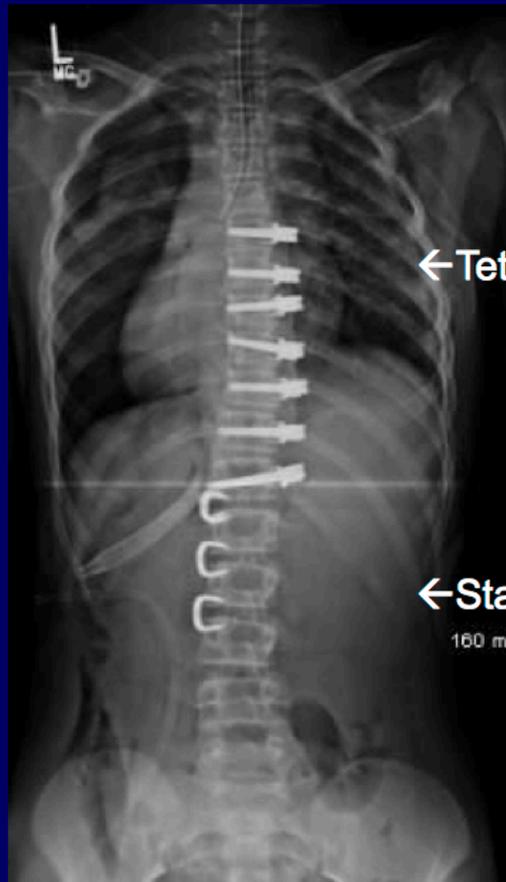


Case #1 Feb 2011 12 yo female

Before surgery



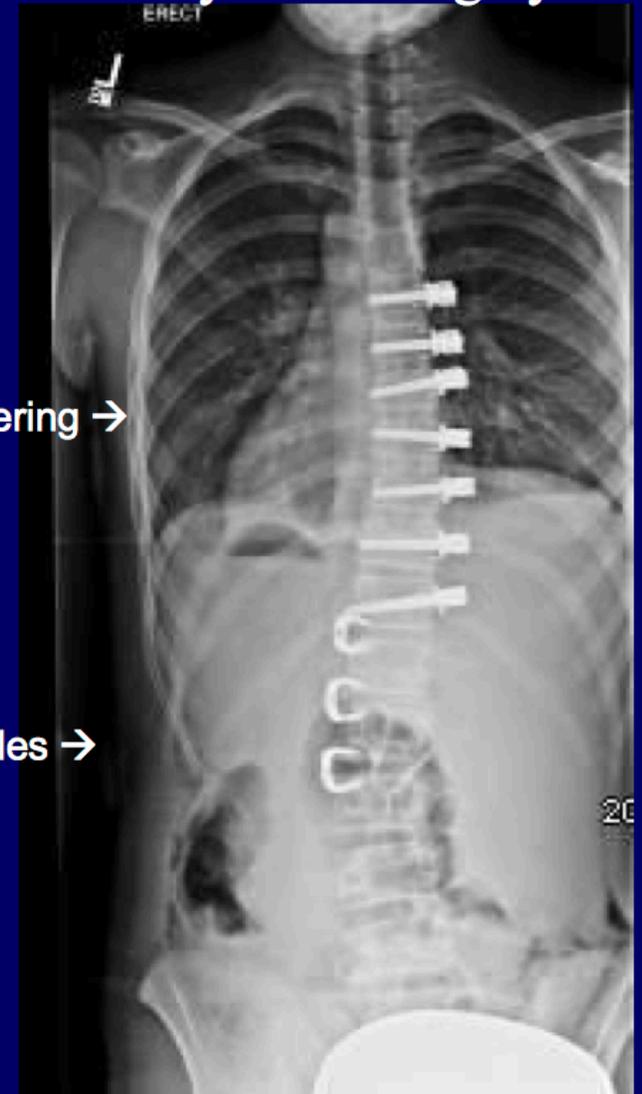
During surgery



←Tethering→

←Staples→

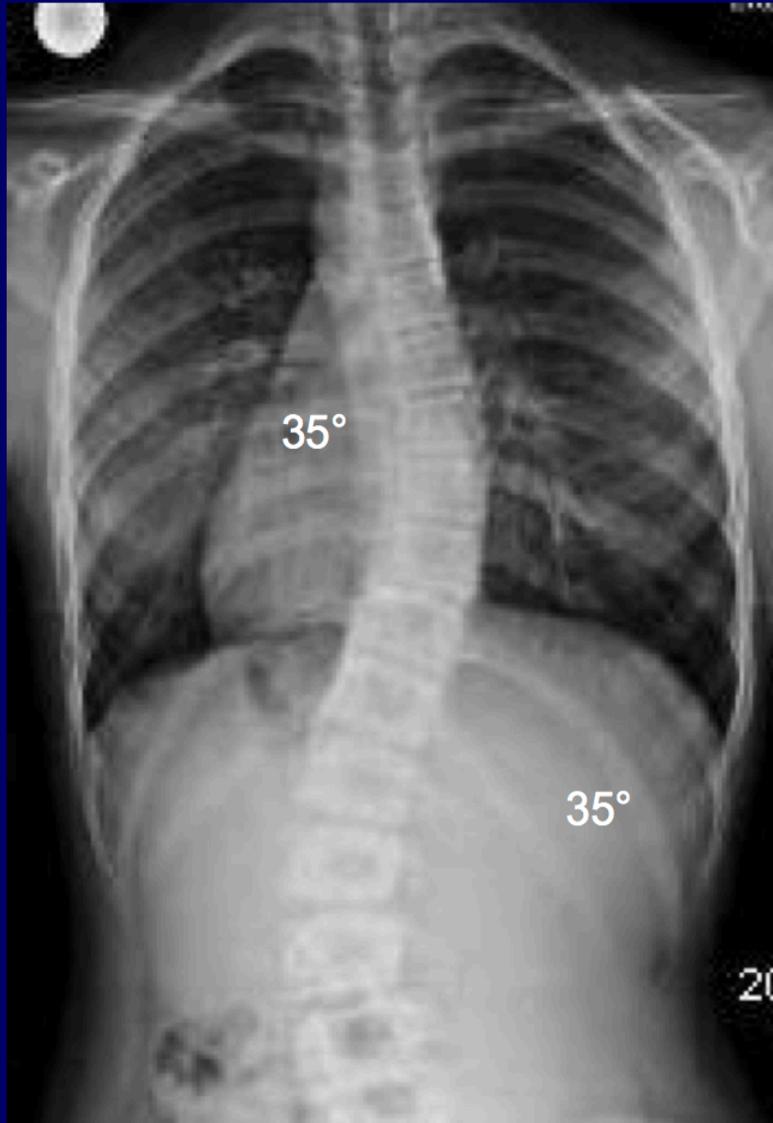
5 days after surgery



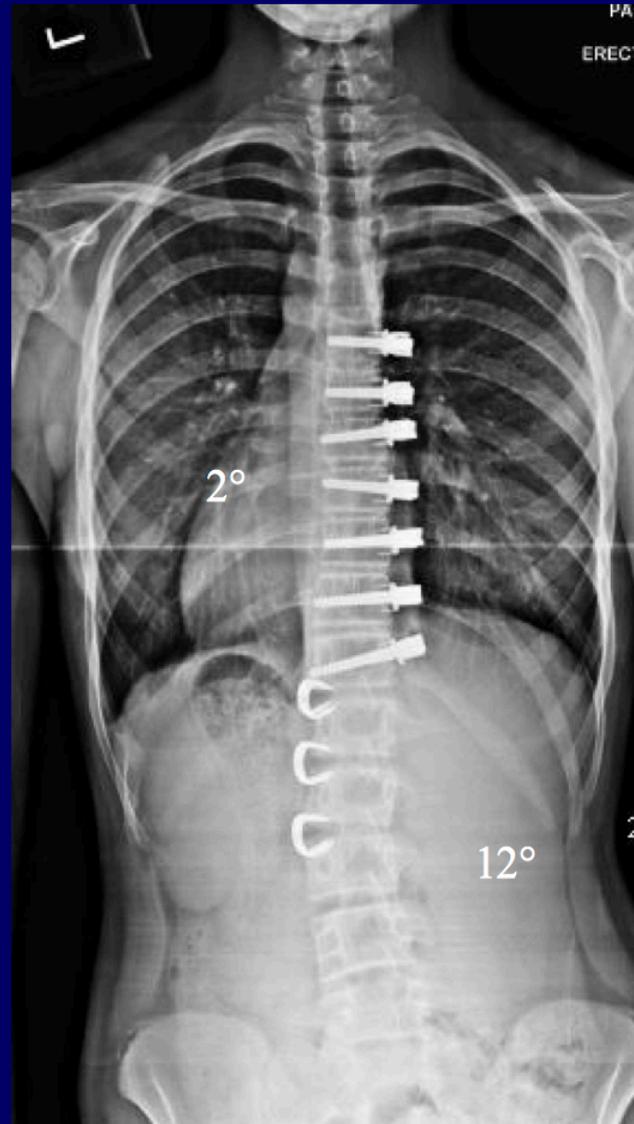
Courtesy Amer Samdani, MD PhD

Case #1

Pre op



1 year post op



Growth Modulation Constructs

Vertebral Body Tethering

▶ Summary:

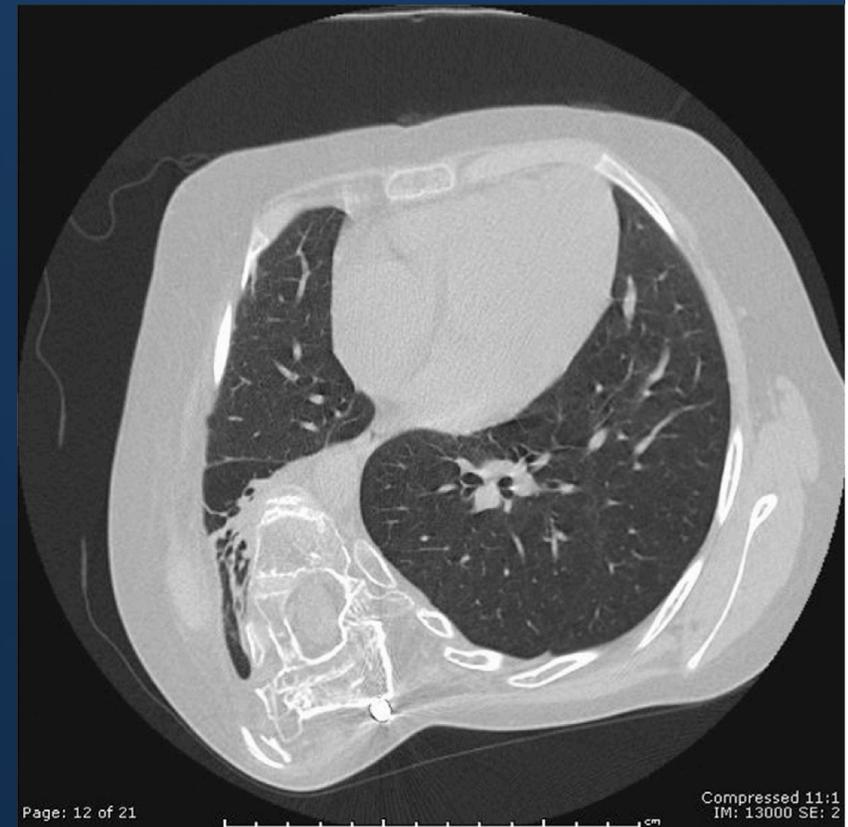
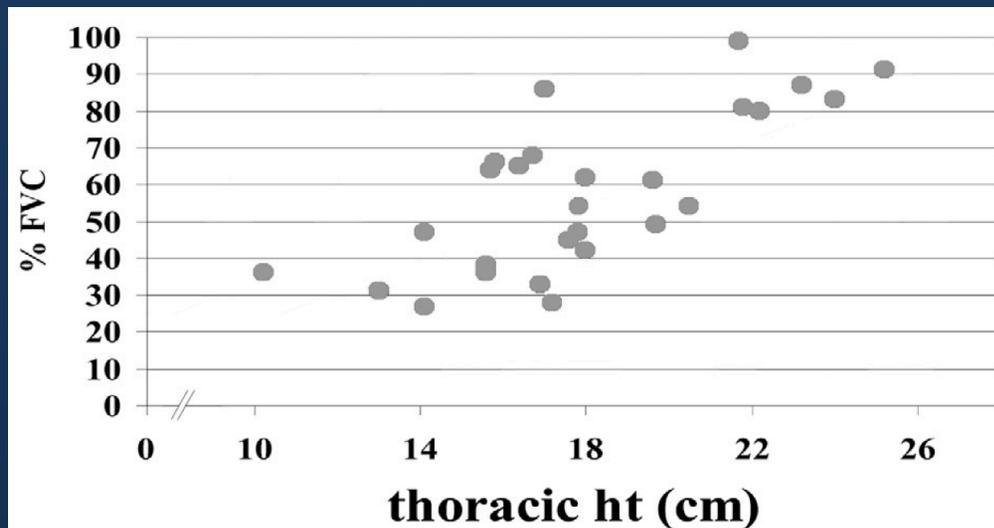
- Powerful correction technique
- Indications still being worked out (timing)
- Pros: fusionless, usually single stage surgery, doesn't burn bridges
- Cons: technically challenging, timing of surgery, possible overcorrection
- Unknown: Disc health, long term follow-up



Spinal Fusion

When all else fails...

- ▶ Try to avoid as much as possible in a child less than 10 years old
- ▶ Karol et al JBJS 2008



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Summary

- ▶ **Classify type of early onset scoliosis to have a chance**
- ▶ **Bracing/casting still has a role**
- ▶ **Growth friendly constructs all have pros and cons**
 - Tailor to patient and EOS type
 - New implants are sexy, but have limited followup
- ▶ **Growth modulation for “older” immature patients is coming... but are we there yet?**



Sometimes it's best to be the second person on the wave..

