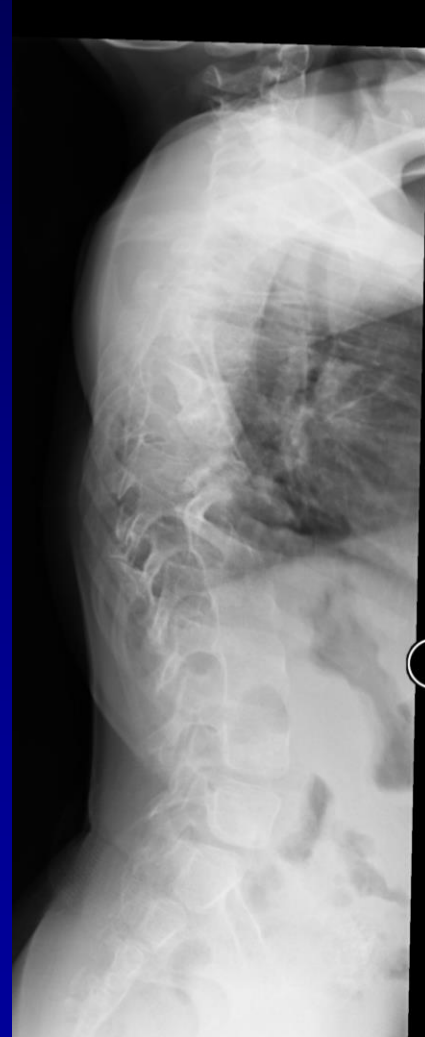


# 5yo with multiple anomalies and rib fusions

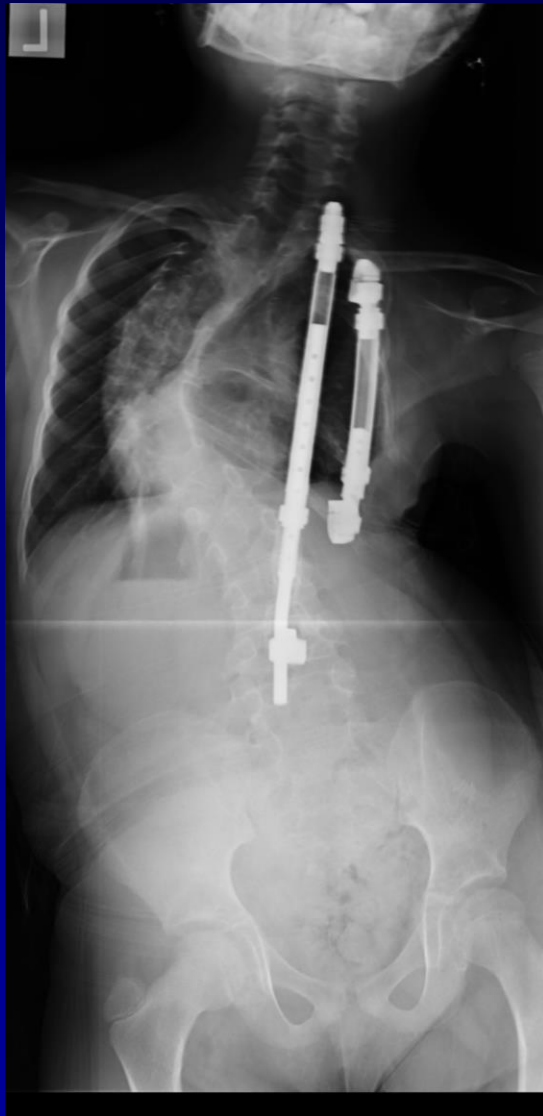


# Early in Brace (not by me) film clarifying deformity

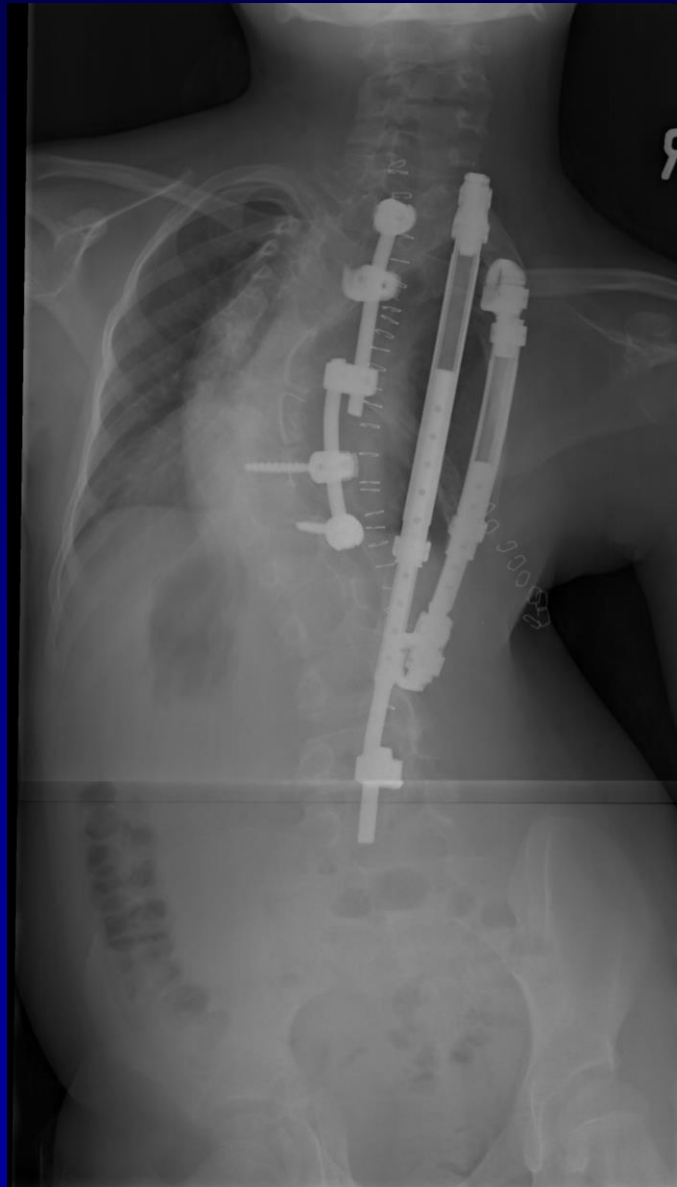


- Two 3-level unilateral bars with contralateral hemivertebrae

# Age 8, VEPTRs with thoracostomy

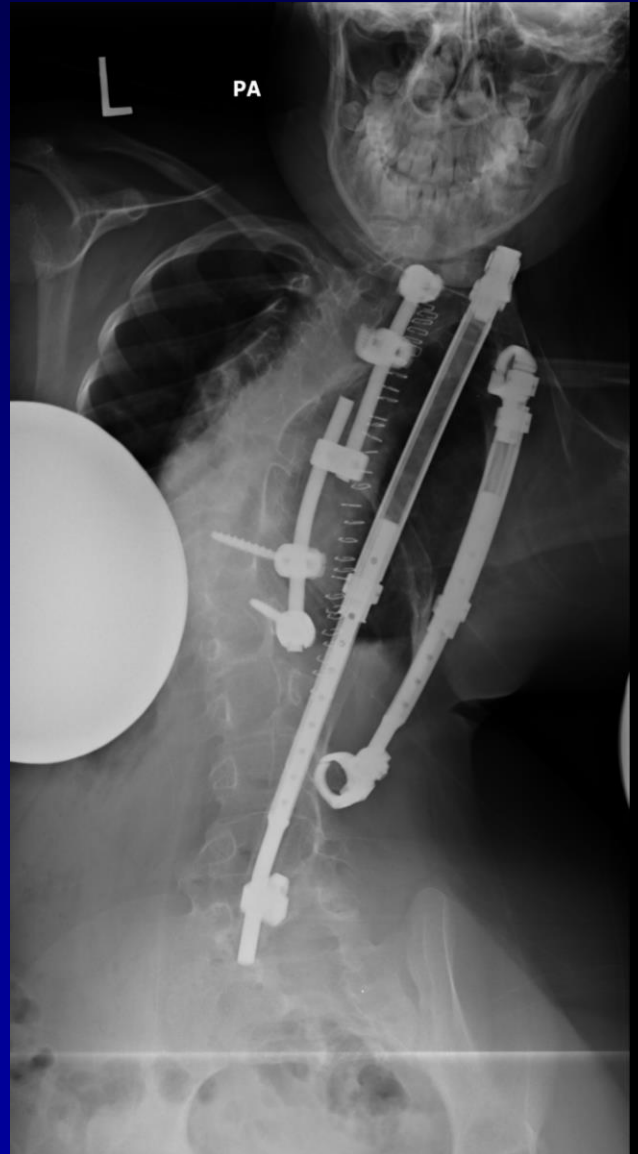


# Age 10 – curve worsening



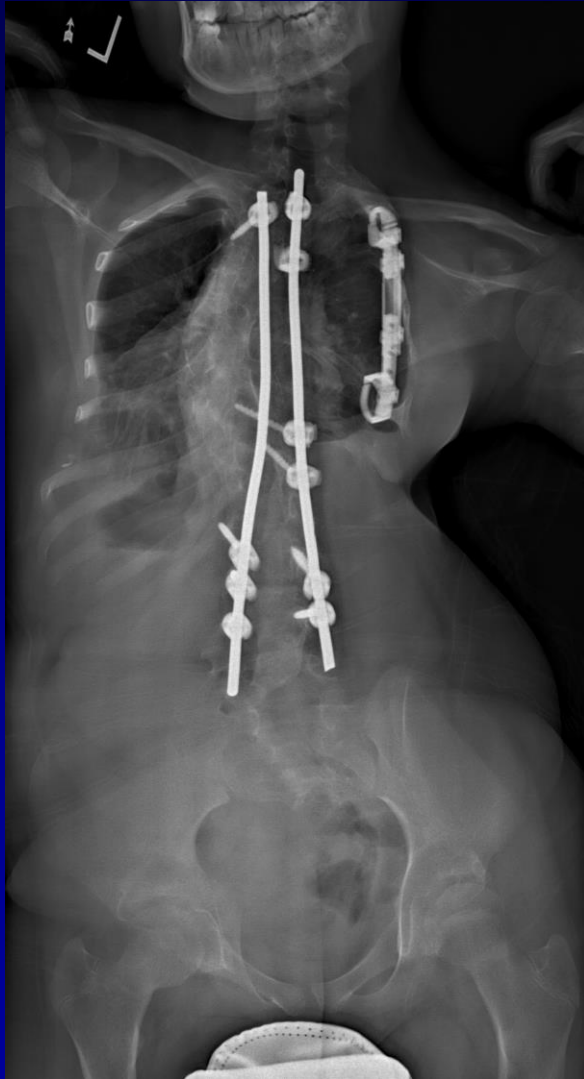
Added a  
growing rod  
between the  
two unilateral  
bars

# Age 12



- VEPTRs could not generate sufficient force to prevent trunk tilting

# Age 13 – “definitive fusion”

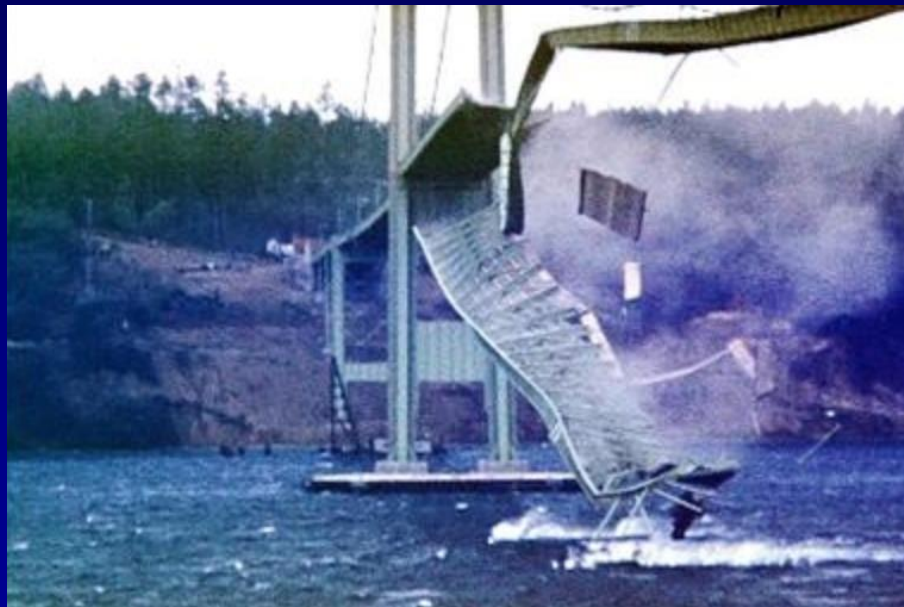


Age 17 – on O2 and methadone



# Pulmonary Function in EOS: Where We Have Failed

*Confessions of a Greg Redding Disciple*



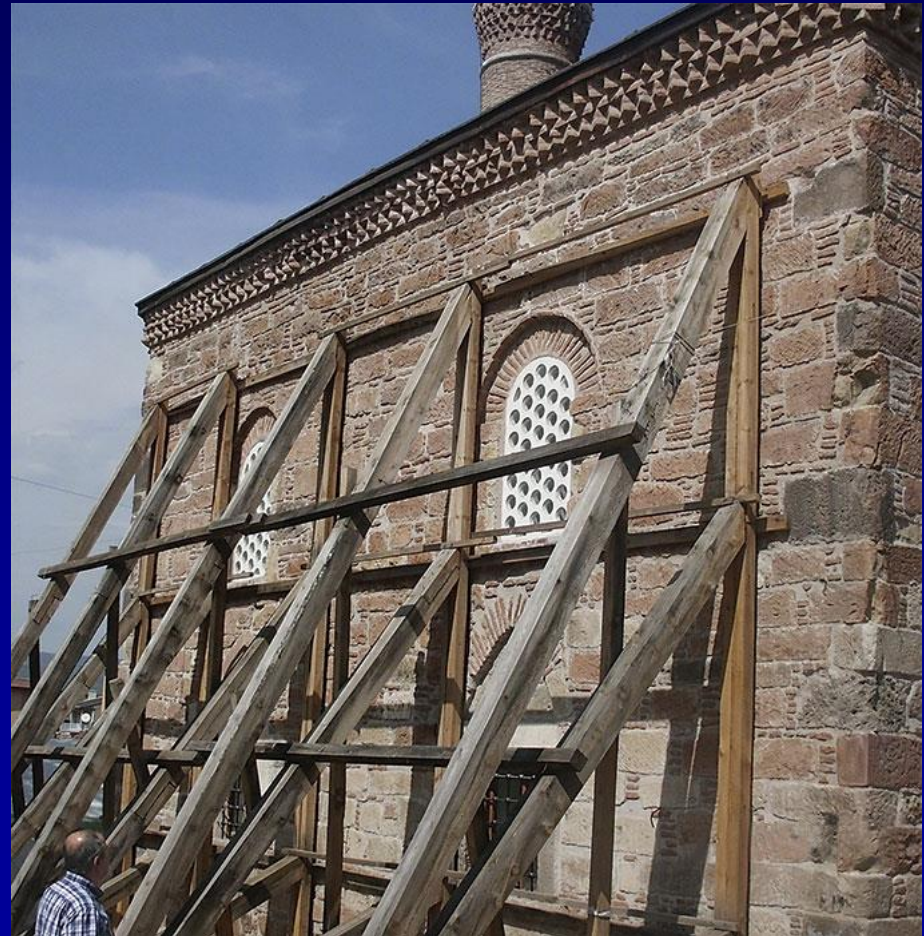
Jim Sanders

Professor of Orthopedics and Pediatrics

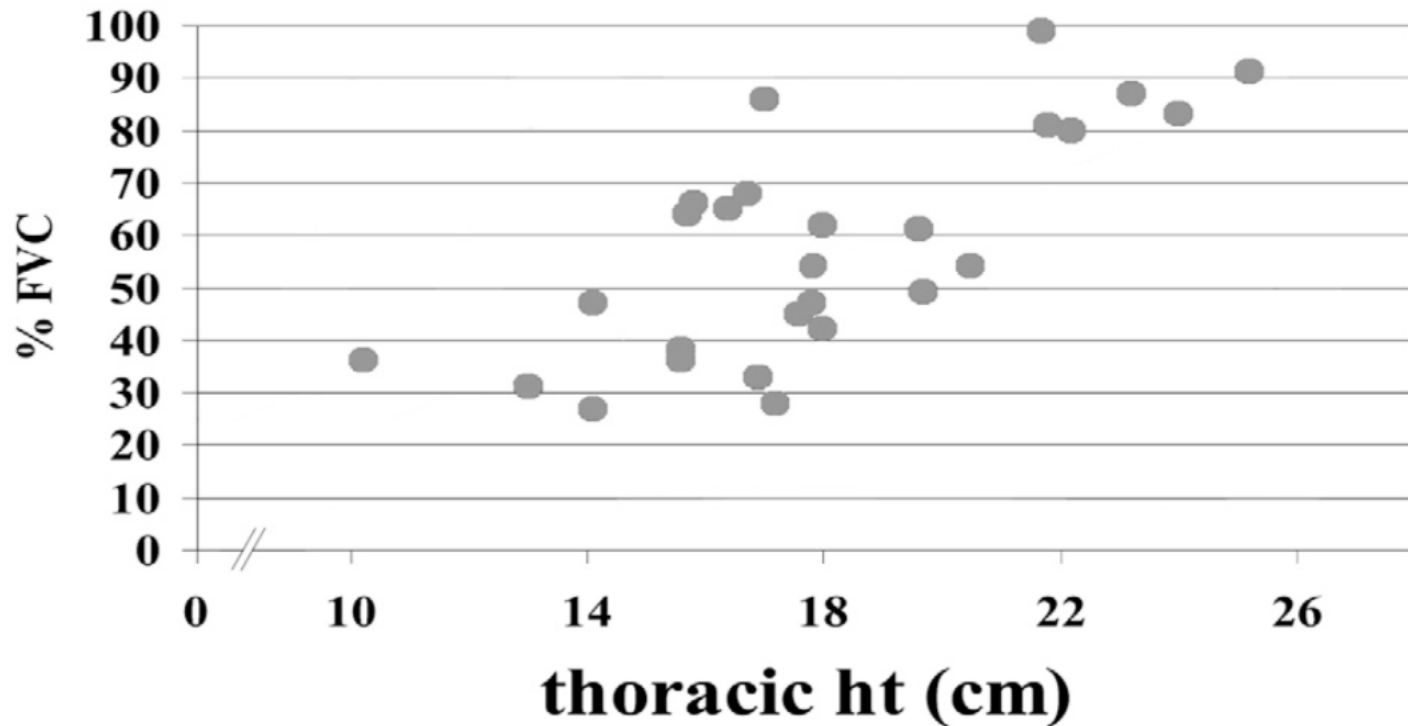
University of Rochester

# Orthopedists Think Structurally

- EOS makes the chest too small.
- Expand a small chest volume
- Lengthen the spine
- Pull or push the ribs into a better position



# Karol, et al: T1-T12 – Based on 28 patients with congenital scoliosis



# Courtesy Greg Redding

## Restrictive Respiratory Disease



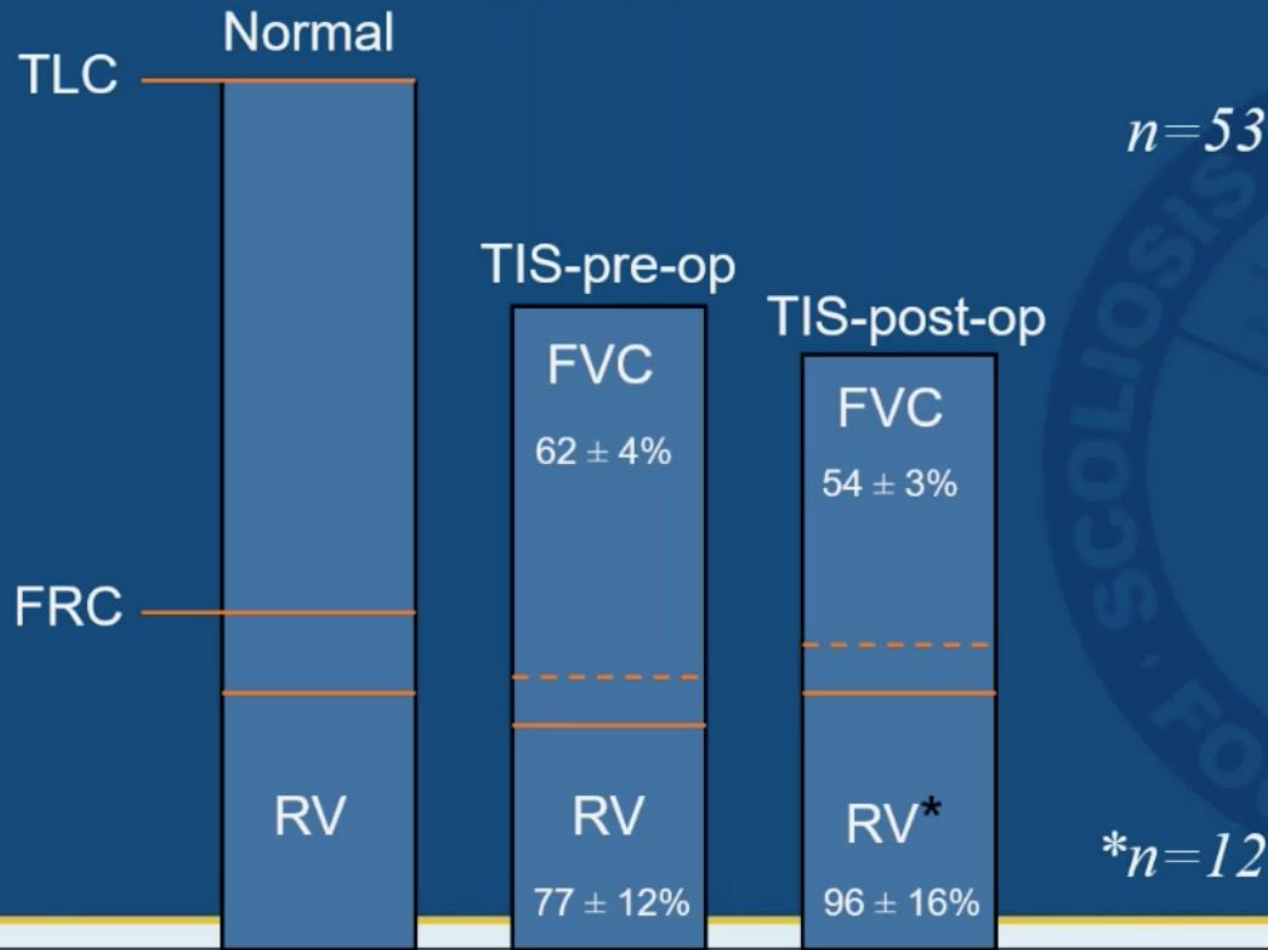
- Loss of lung volume and lung distensibility
- Loss of rib mobility and normal chest wall expansion with inspiration
- Increased reliance on diaphragm function as the primary muscle of inspiration

# Additional Consequences of TIS

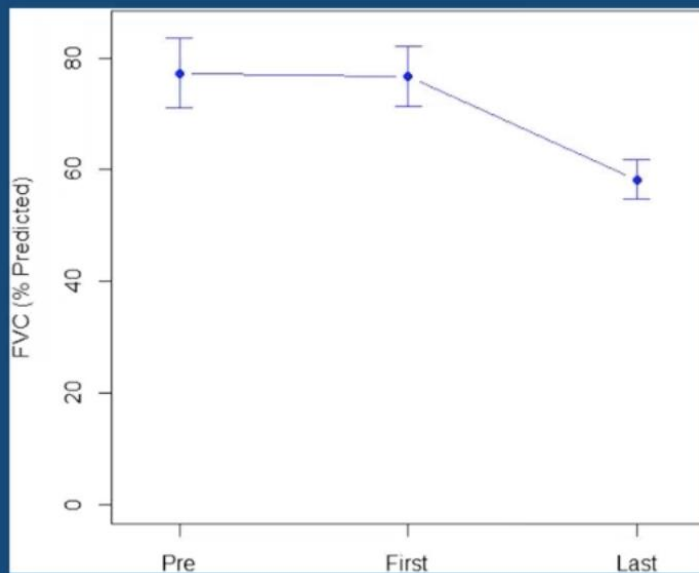
- Diminished cough effectiveness, with prolonged and severe respiratory infections
- Diminished exercise tolerance
- Airway torque and kinking with localized airway obstruction
- Pulmonary hypertension and cor pulmonale
- Hypercapnia (respiratory failure)
- ?Postnatal lung growth arrest



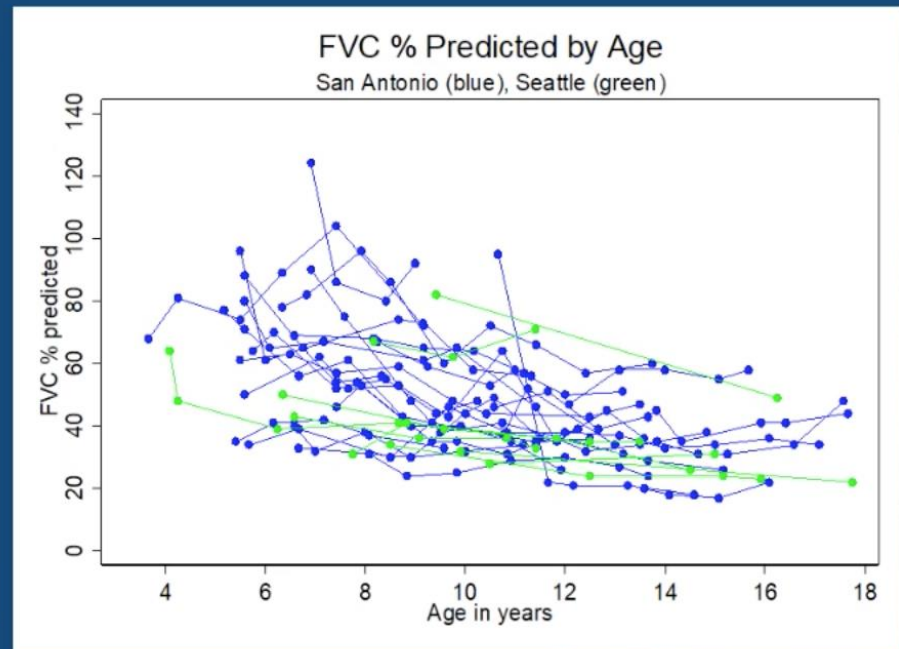
# Lung Volumes Before and 6 Months After Growing Construct with Rib Based Device Insertion



# Serial FVC Over a 6 Year Interval



28% Reduction from Pre to LAST

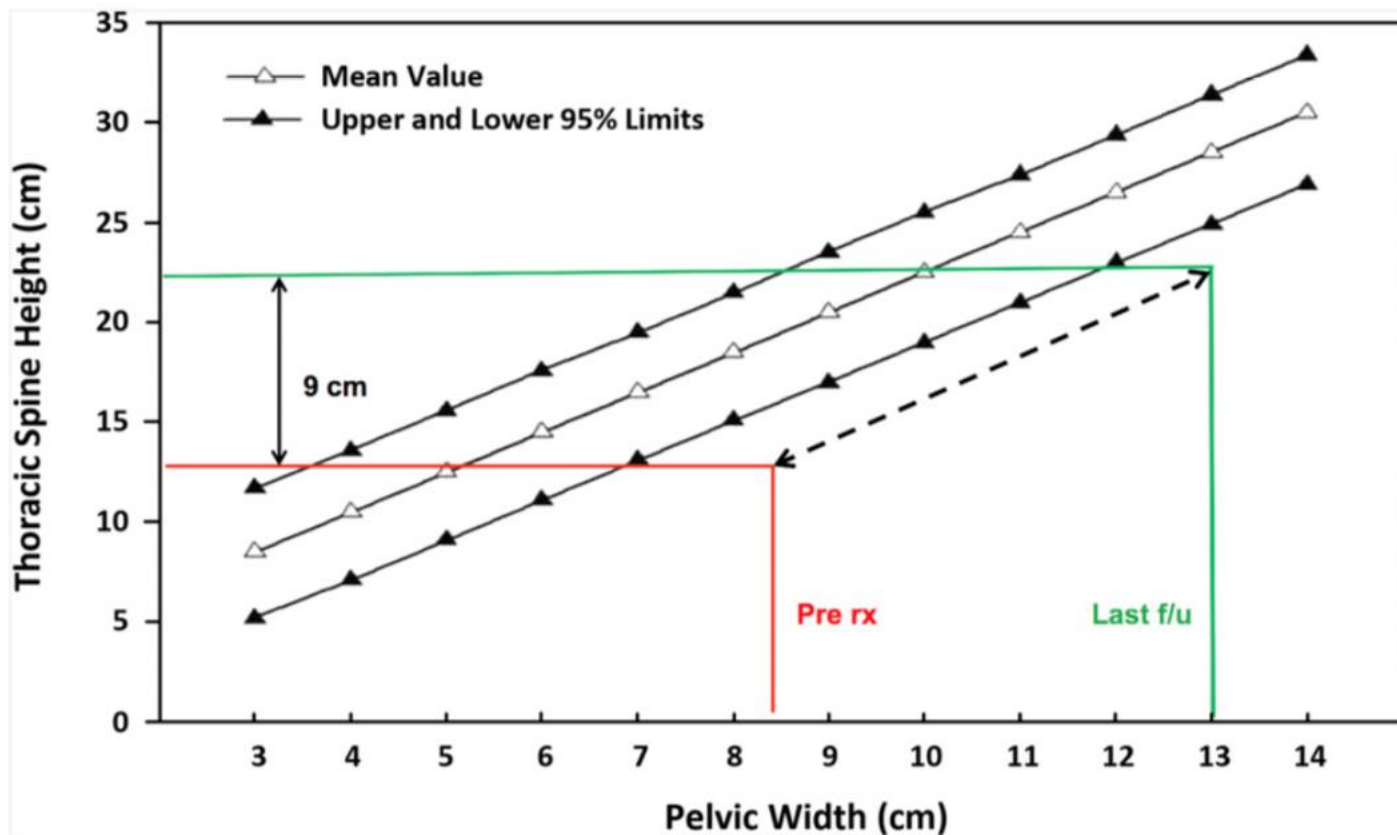


16% Reduction Over 6 Years

Dede O et al. *J Bone Joint Surg Am* 96:1295-1302, 2014.

**Redding G.** Longitudinal trends over 5 years in Cobb angle, lung function, and nutritional status in children with EO. ID: 1500 E-Poster. 50<sup>th</sup> SRS Annual Meeting & Course, Abstract Minneapolis, Minnesota, September 30 – October 3, 2015.

# The Johnston Concept:



# What do we really do?

Goal:

- Lengthen spine to make a bigger box.
- Push up the ribs to increase chest diameter.
- Correct lordosis/rotation to improve airway geometry

But:

- Create spontaneous spine fusion
- Create rib fusions minimizing expansion/contraction
- Do we really correct the airway issues?

# What about our outcomes?EOSQ-24

## **Pulmonary Function: During the past 4 weeks**

**5. How difficult has it been for your child to cry/babble/speak (appropriate for age) without experiencing shortness of breath?**

Difficult

Somewhat Difficult

Neutral

Somewhat easy

Easy

**6. How often has your child experienced shortness of breath during activities?**

All of the time

Most of the time

Some of the time

A small amount of  
the time

None of the time

## **Physical Function: During the past 4 weeks**

**8. How difficult has it been for your child to move his/her upper body?**

Difficult

Somewhat difficult

Neutral

Somewhat easy

Easy

**9. How difficult has it been for your child to sit up on his/her own?**

Difficult

Somewhat difficult

Neutral

Somewhat easy

Easy

**10. How difficult has it been for your child to keep his/her balance while crawling, walking, or running?**

Difficult

Somewhat difficult

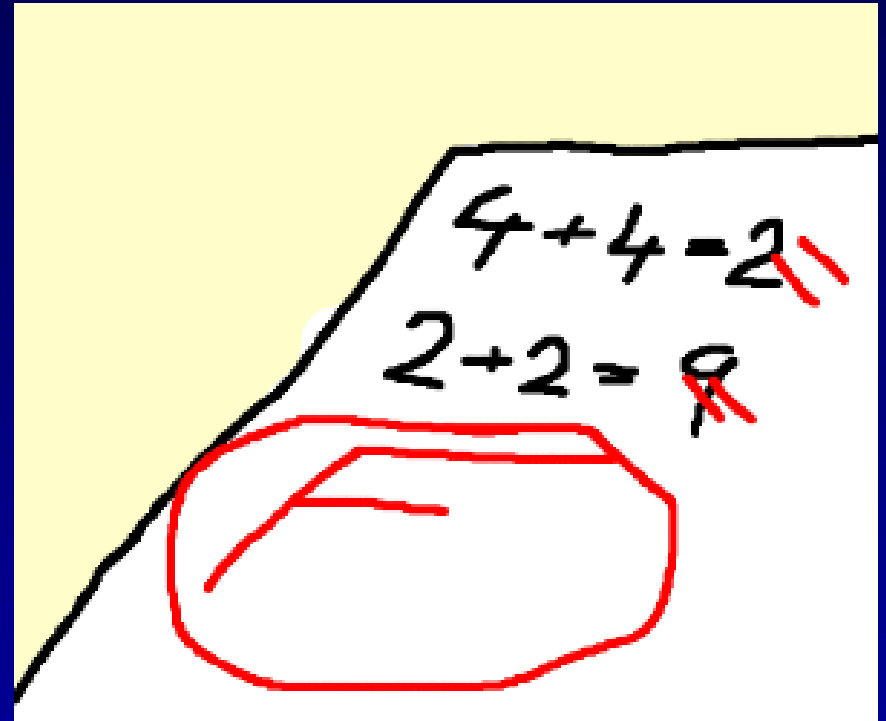
Neutral

Somewhat easy

Easy

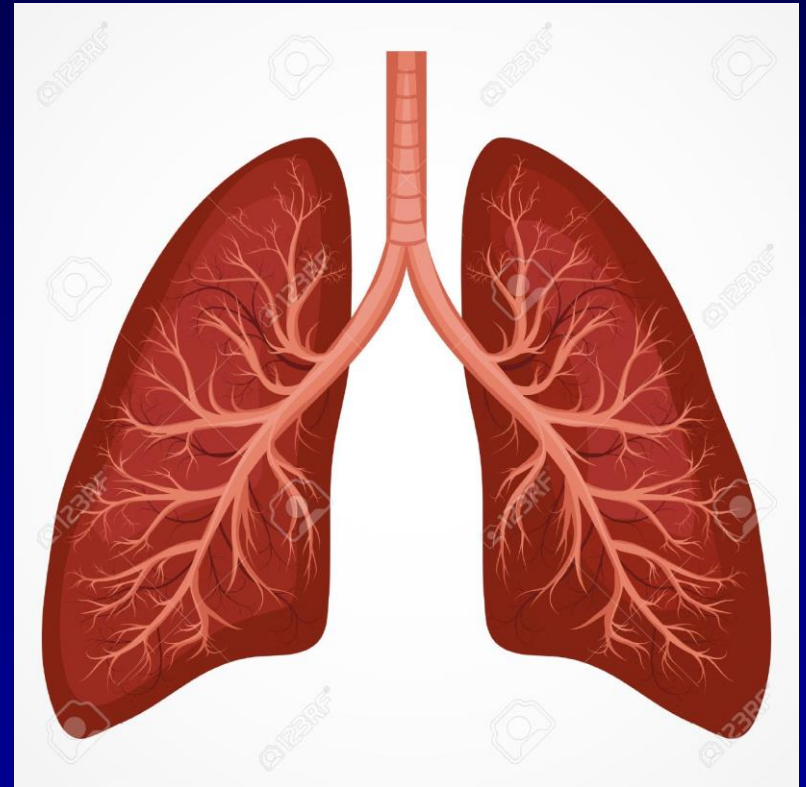
# Where have we failed?

- Focus on Cobb angles or spine length
- Both poorly related to what children's needed pulmonary function
- Outcome measures not adequately addressing the pulmonary domain



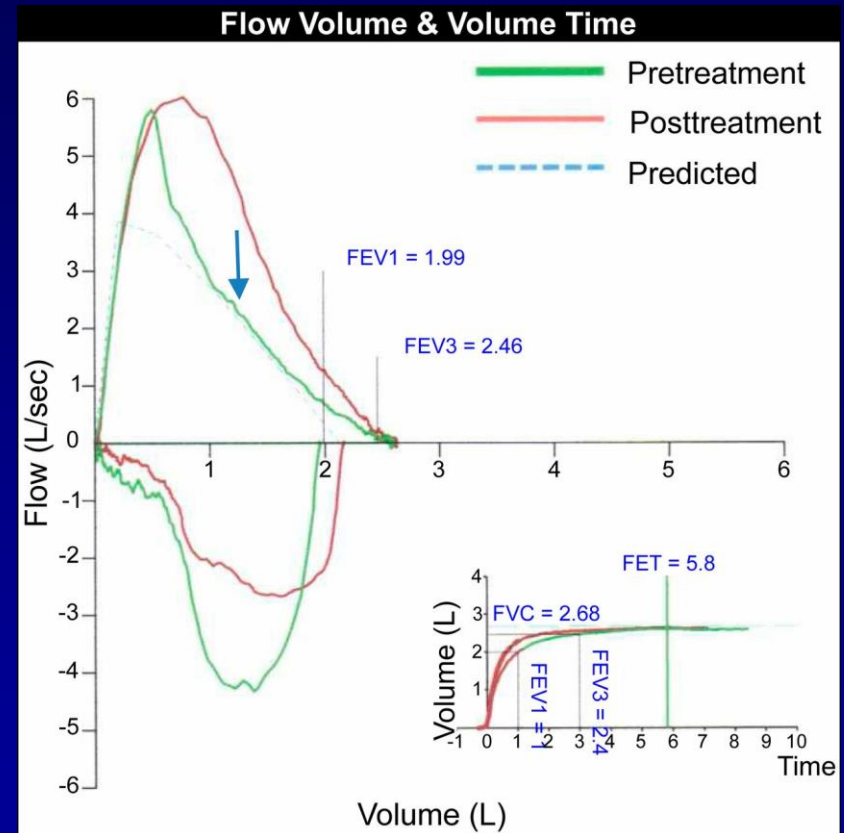
# What's needed?

- Effective chest volume expansion and contraction.
  - Intercostal Muscles
  - Diaphragm
  - Costovertebral joints
  - Rib alignment
  - CNS control
  - Adequate baseline volume
- Lung parenchyma that permits effective gas exchange
- Unobstructed airway geometry



# Step 1: Adequately determine pulmonary status

- PFTs are hard to get in children.
- Nearly impossible in young children.
- PFTs only provide limited data and not function.



# The Redding Construct:

- If children are breathing well, then three things should happen.
- If not, they will be negatively effected:
  - Do they sleep?
  - Do they play(work)?
  - Do they grow?



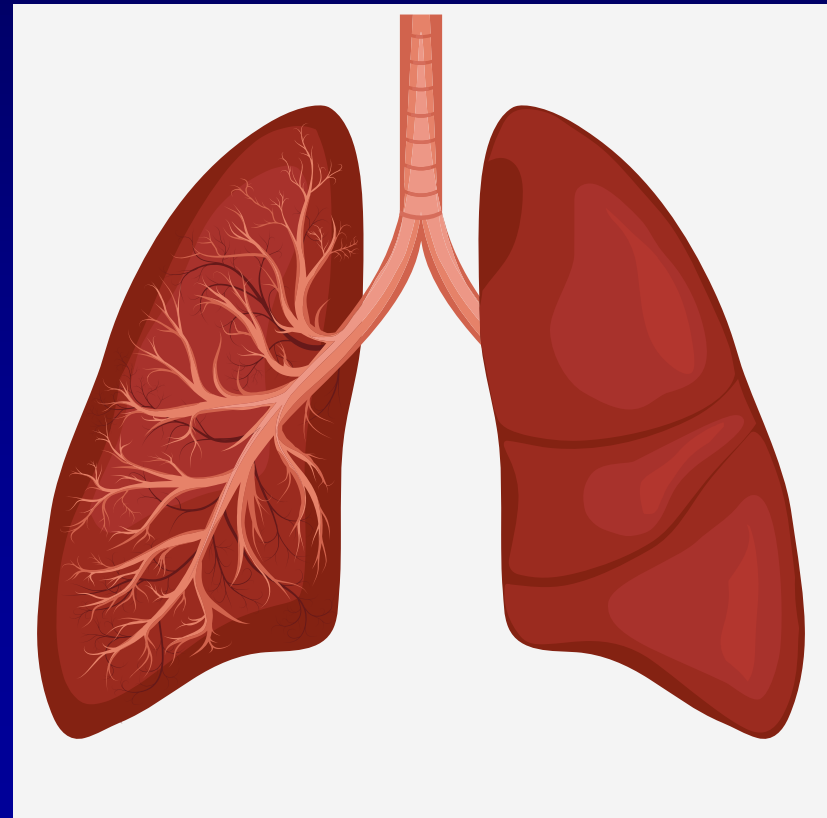
# Pulmonary Function Domains

- Do they sleep?
  - Sleep studies
- Do they play (work)?
  - Need to develop criteria
- Do they grow?
  - Need to define uniform growth parameters for children with differing disorders

# Step 2: The orthopedic mental change

- start considering chest volume in EOS as dynamic not static

- Our current devices work to make a static box bigger.
- Can we design implants or supports that facilitate rather than block motion?



# We need a better paradigm

- It's not just a bigger box.
- It's dynamic expansion and contraction with a bigger box—a larger, more effect bellows.
- Listen to Redding—pulmonary function has three main domains:
  - Can they sleep
  - Can they play (work)
  - Do they grow?
- We need to measure them well.