Pulmonary Functions and Testing in Children

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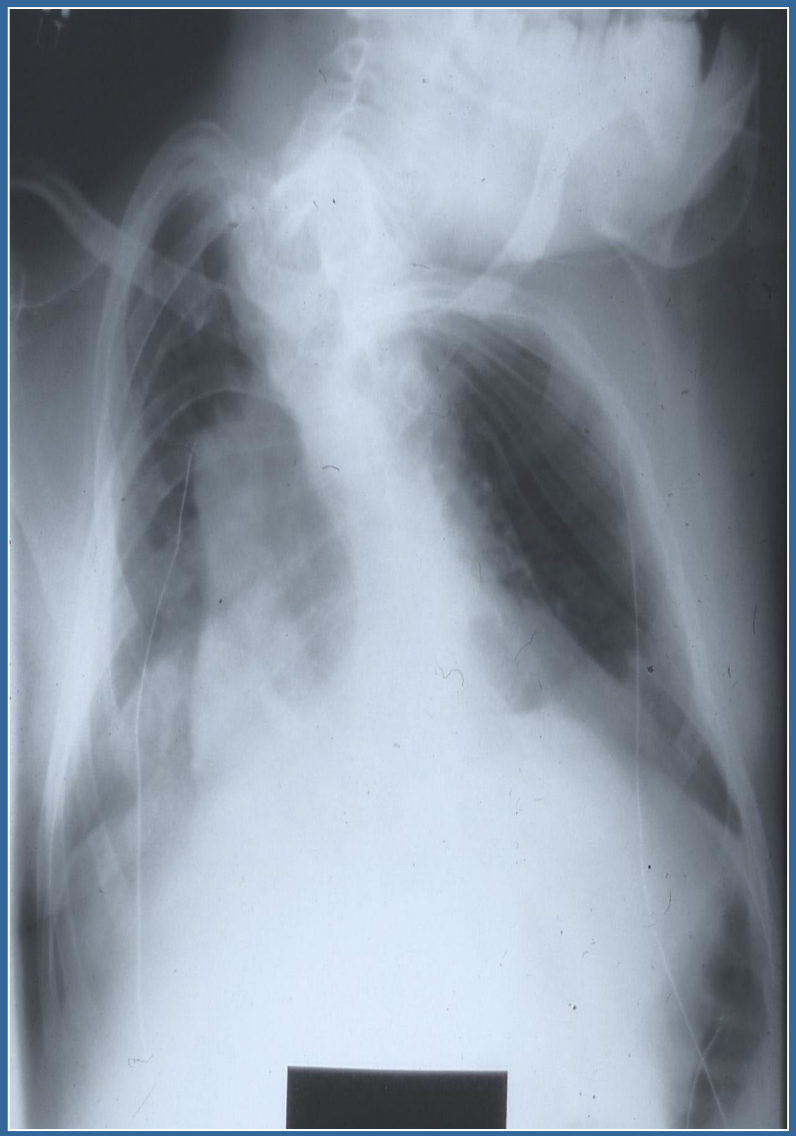
Thoracic Structure and Function

Scoliosis

Kyphosis

Rotation

Distortion



Work of Breathing

Chest Wall Movement

Asymmetric Ventilation

Respiratory Muscle Function

Questions based on both Structure and Function:

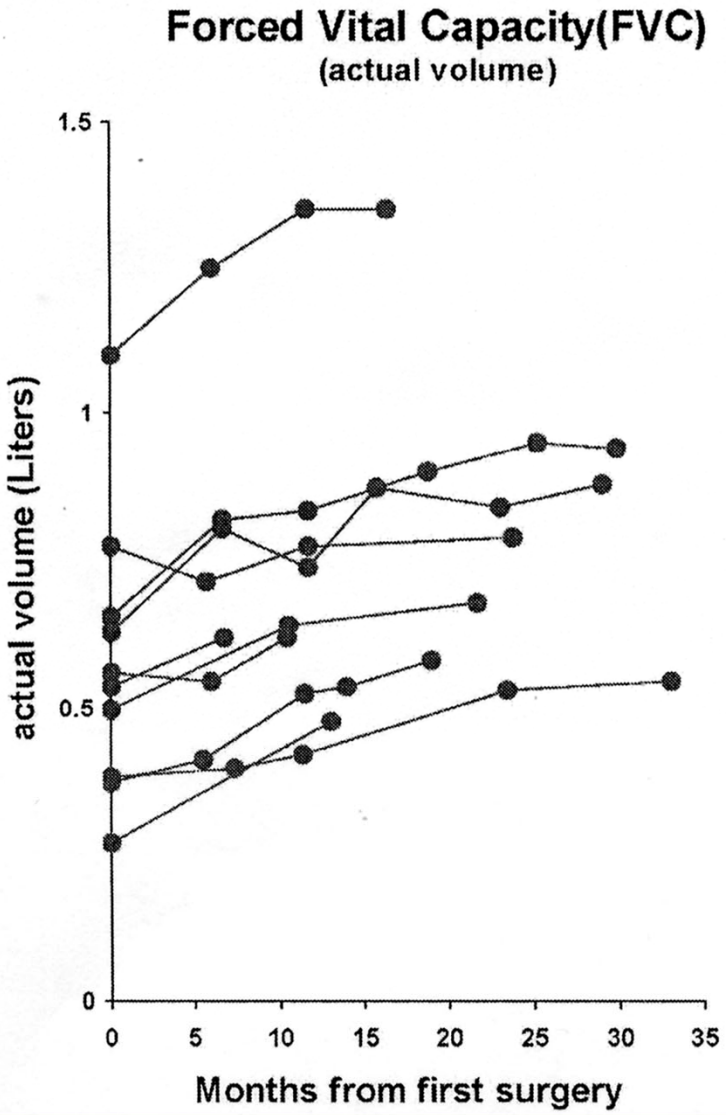
1. Severity at the time of initial encounter
2. Progression of disease
3. Effect of intervention (VEPTR implantation and expansion)

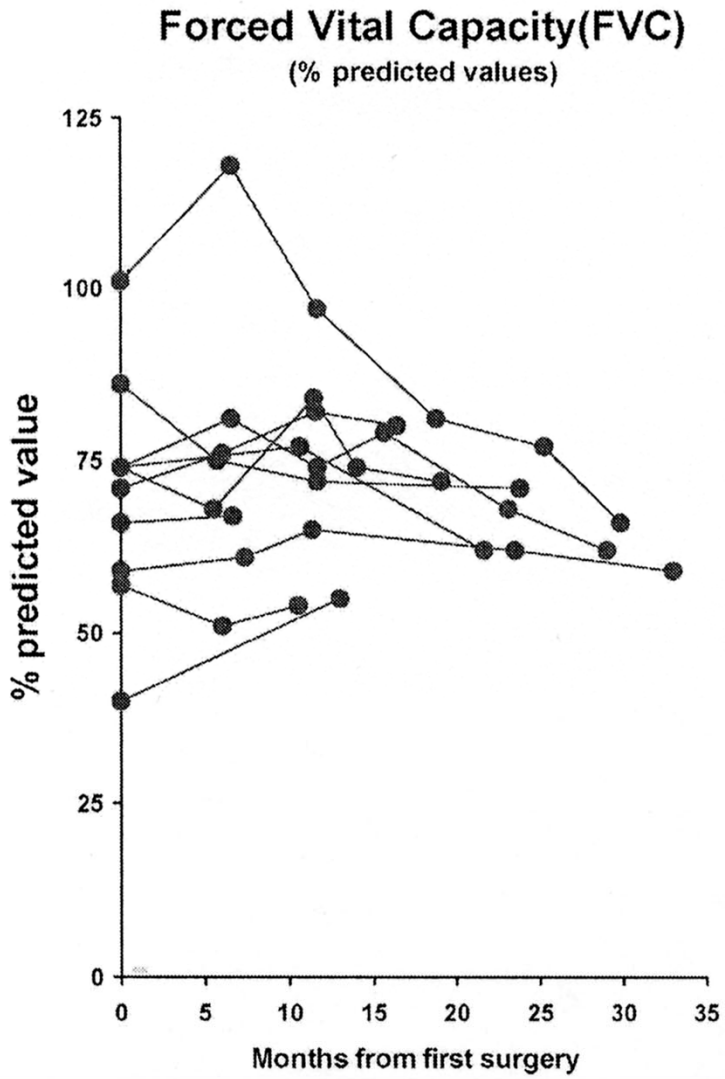
Combinations of pulmonary function tests may clarify why lung function in compromised (small lung volumes vs diaphragm weakness)

Serial Pulmonary Assessments May Help Determine:

1. When to intervene ???
2. Both short and long-term benefits of interventions

Serial Lung Functions Following Initial Expansion Thoracoplasty





Motoyama EK, et al. *Spine* 31:284-290

Settings of Pulmonary Function Testing

- Outpatient Pulmonary Function Lab
  (Adult, pediatric, infant* lung function testing)
- Operating Room*
- Sleep Laboratory

<u>Testing Conditions</u>

- Awake and resting
- Asleep
- Sedated or anesthetized*
- During Exercise
- Supine vs Upright

Infant Pulmonary Function Equipment

Pulmonary Function Testing in Infants and Children

	Invasive	Non-Invasive
Effort--Dependent*	Trans-Diaphragm Pressures	Spirometry Respiratory Muscle Strength and Endurance
Effort--Independent	Chest Wall & Lung Compliance Lung volumes	Oximetry, Blood Gas Tensions, Perfusion Scan, Sleep Study, Echocardiogram

*Voluntary Effort at 5-6 Years of Age

PFT Results: Compared to What?

- Values normalized for growth, gender, age
- Height values can’t be used in scoliosis
- Variation between testing facilities
- Variation until techniques are mastered
- Variation based on position
- Day to day variation in FVC is <10%

Forced Vital Capacity

- Maximum breath out after a maximum breath in
- Active voluntary effort while standing or sitting
- Low cost test equipment (spirometer)
- Reflects multiple respiratory components:
  - Lung volume
  - Lung and chest wall compliance
  - Respiratory muscle (inspiratory and expiratory) function

Pulmonary Evaluation Techniques in Children

Test	Index	Age of Useful Measurement
Respiratory rate	Sleep rate	All ages (age-specific norms)
Oxygenation	SaO2 in room air (Awake vs Asleep)	All ages
Ventilation	CO2 (capillary) or HCO3	All ages
Spirometry	Forced vital capacity (FVC)	5-6 years (using arm span)
Respiratory muscle strength	Maximal inspiratory and expiratory pressure	6-8 years
Exercise tolerance	Maximal oxygen consumption, external work, ventilation	8 years
	6 minute walk?	5 years
Echocardiogram	Estimated pulmonary artery pressure Right ventricular wall thickness	All ages (may need sedation)
Ventilation scan	Right vs. left ventilation Homogeneity of ventilation	5-6 years
Perfusion scan	Right vs. left lung blood flow	Any age (may need sedation)

Summary: PFTs are Indipensible!

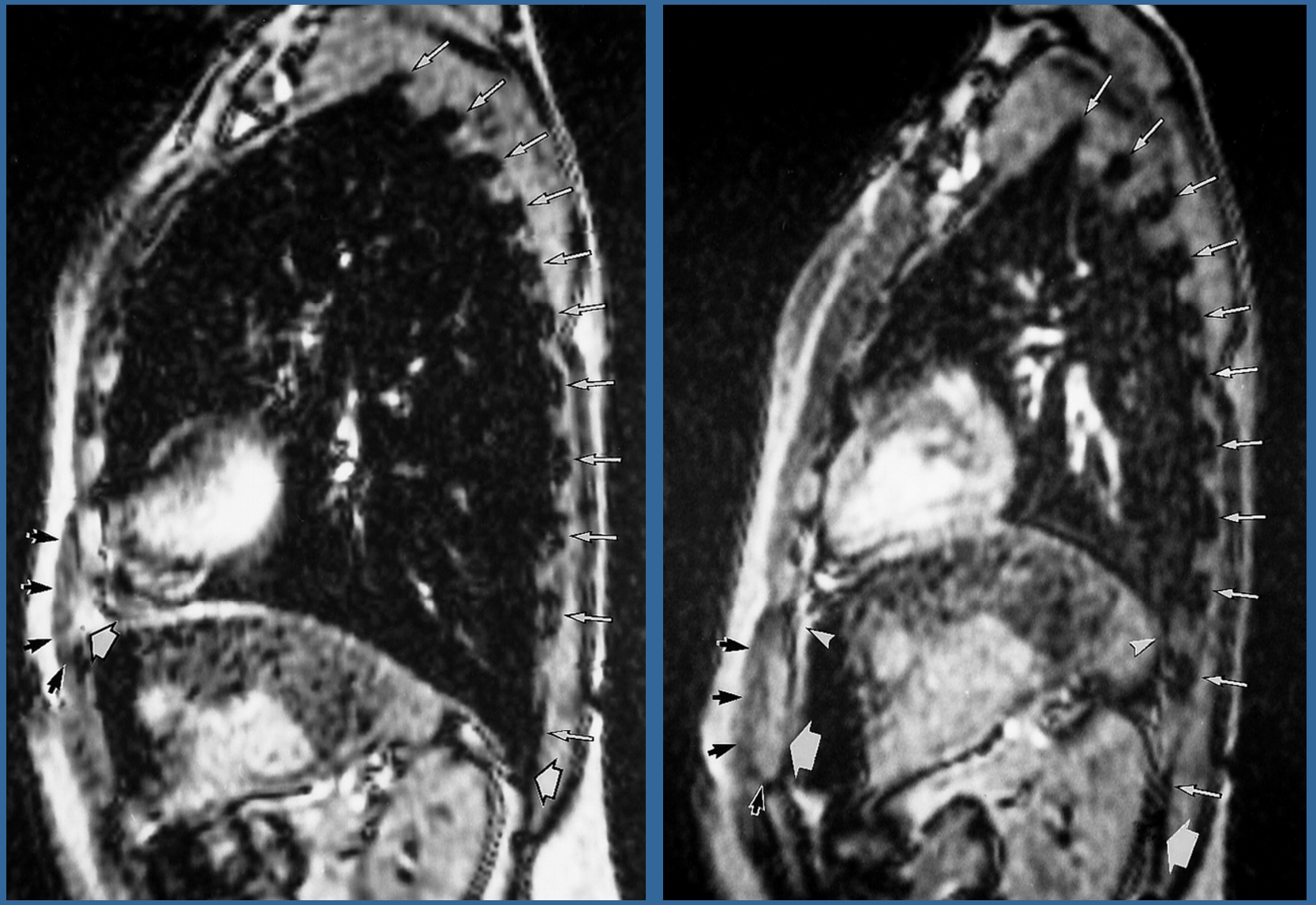
- Selected pulmonary functions, such as forced vital capacity (FVC), should be used in conjunction with structural features in deciding when to intervene for EOS.
- Pulmonary functions over time will help detect trends as deformities progress and improvements after therapy.
- Combinations of lung functions may describe why respiration is compromised but their prognostic value is unclear (lung scans, diaphragm motion).

TIS Severity Score: Evolving Functional Considerations*

Severe:	Ventilator Dependent
	CO_2 Retention
	Cor Pulmonale
	Vital Capacity <50%
Moderate:	Failure to Thrive
	Asymmetric Lung Function
	Vital Capacity 50-70%
Mild:	Vital Capacity >70%
	Exercise Limitation

**Excluding Neuromuscular Weakness Conditions*

Images Don’t Quantitate Lung Function



Cluzel, P. et al. *Radiology* 2000;215:574-583