

# Defining Parasol Rib Deformity in Hypotonic Neuromuscular Scoliosis: Is there a difference between VEPTR and Growing Rods?

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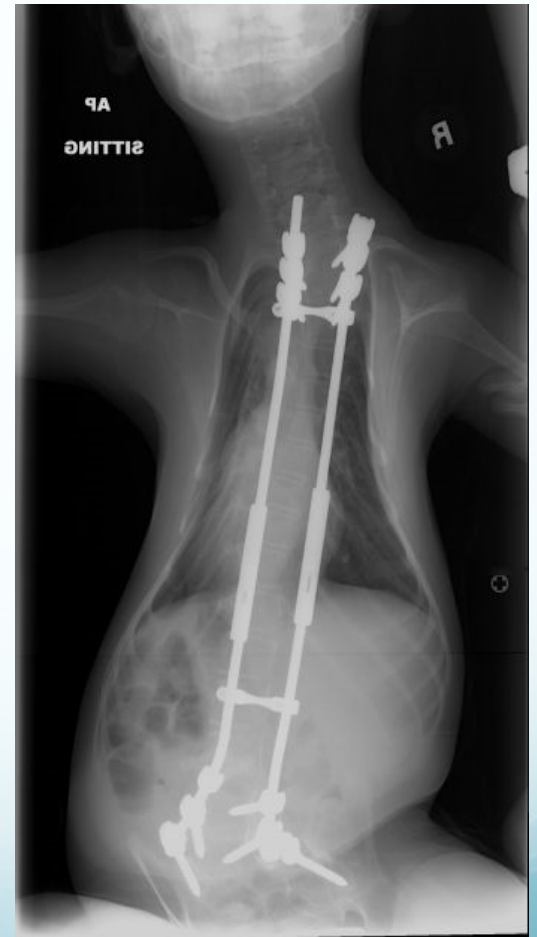
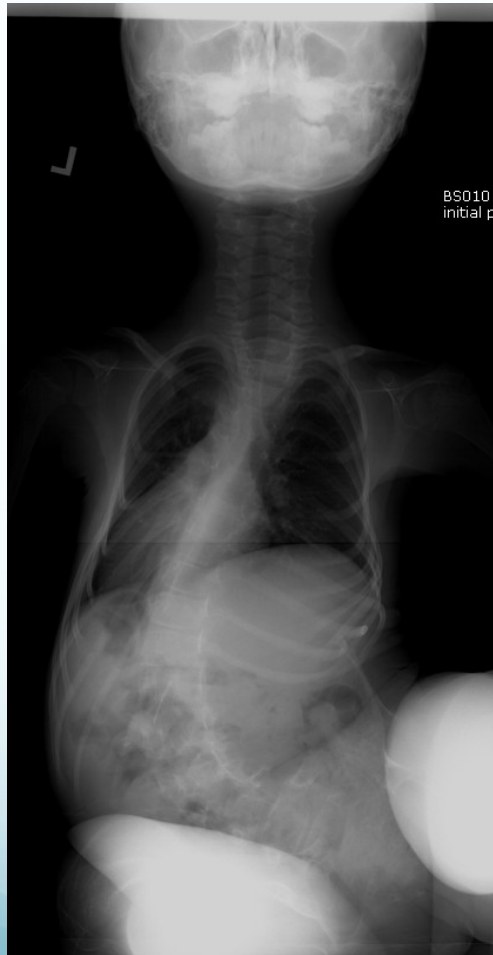
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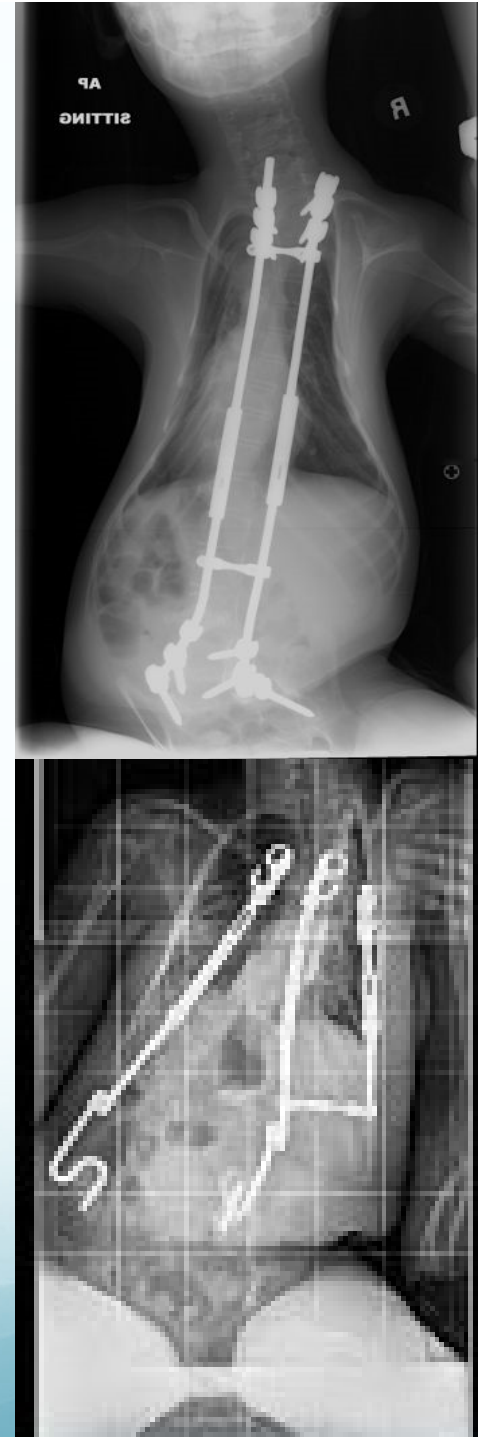
(No disclosures)

# How are we doing?



# Study Goals

- To define parasol rib deformity radiographically
- To compare the efficacy of VEPTR vs. growing rods in controlling parasol rib deformity
- To determine if these interventions improve pulmonary function



# Methods

- Retrospective review
  - Growing Spine Study Group (GSSG)
  - Chest Wall and Spine Deformity (CWSD)
- Inclusion criteria:
  - Dx: hypotonic neuromuscular scoliosis
  - Tx: with Vertical Expandable Prosthetic Titanium Rib (VEPTR) or growing rods (GR)
  - At least 1 year follow up
- Exclusion criteria: inadequate records/imaging

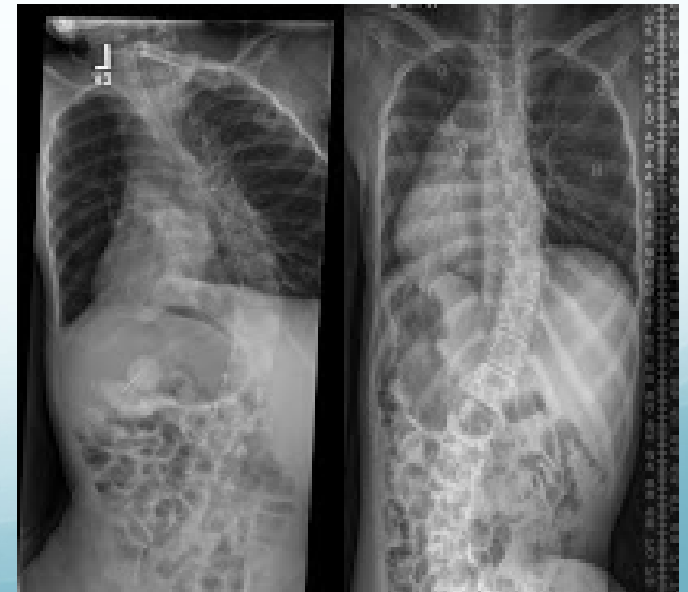
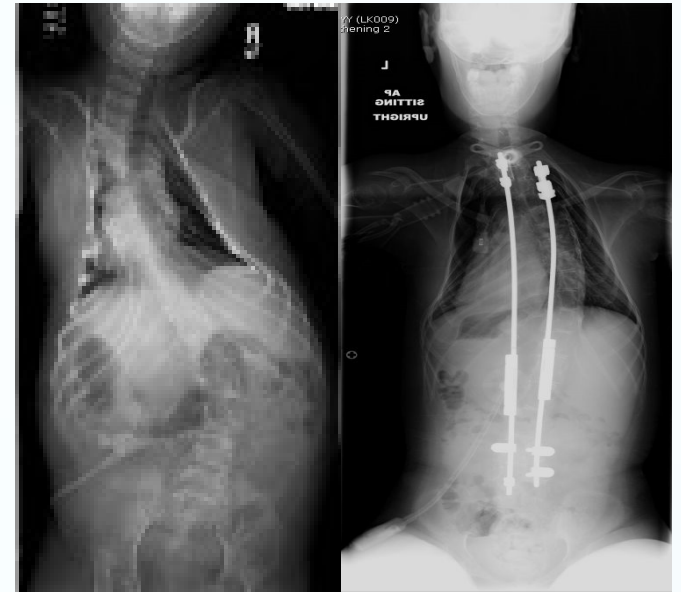
# Clinical Data

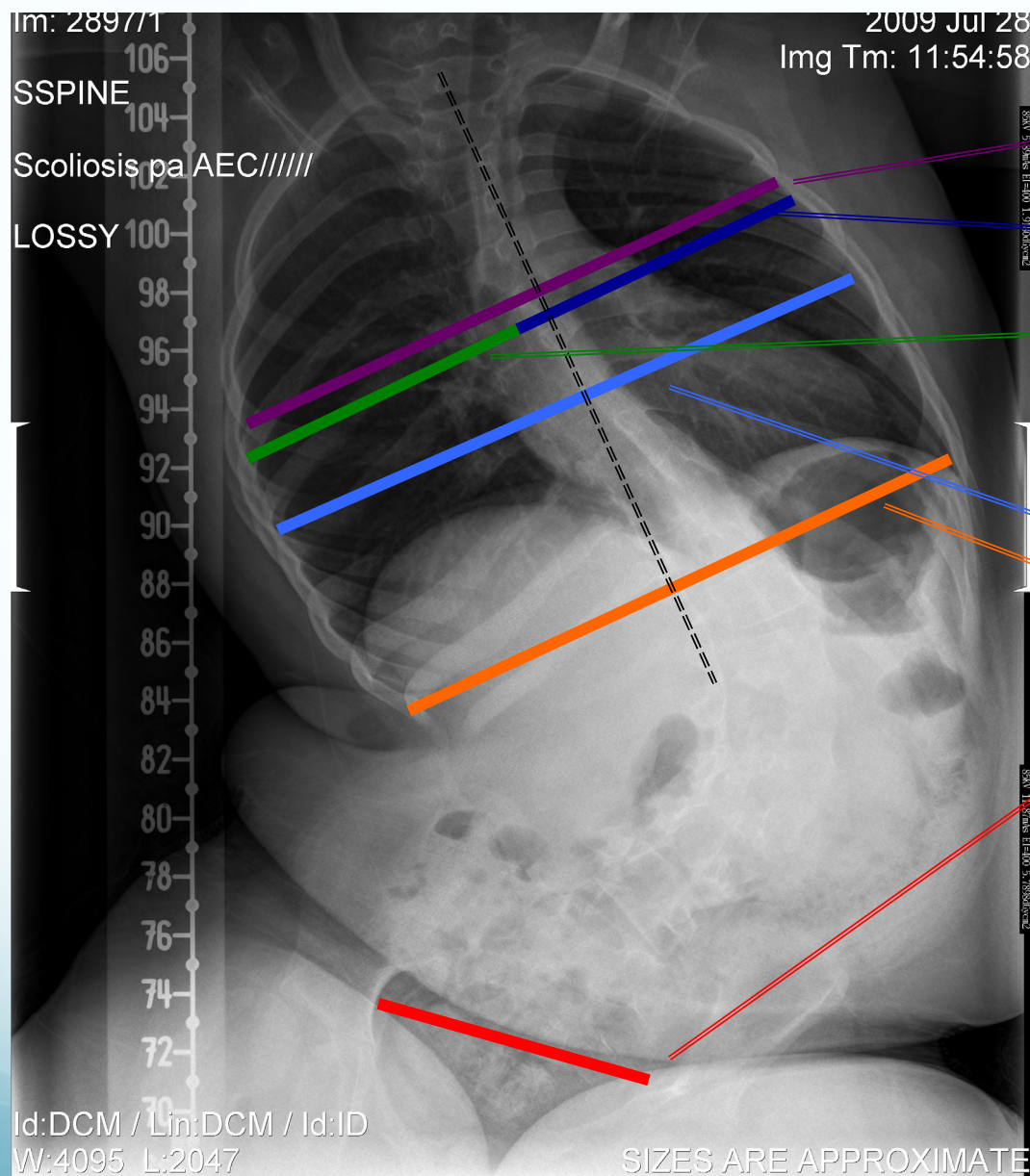
- Gender
- Age at index surgery
- Diagnosis
- Number of lengthenings
- Complications
- Preoperative and final assisted ventilation rating

Parasol Rib Collapse?

OR

Not?





**T6 total width**

**T6 concave width**

**T6 convex width**

**Maximum thoracic  
width**

**T12 width**

**Pelvic inlet width**

**Cobb angle**

**Kyphosis**

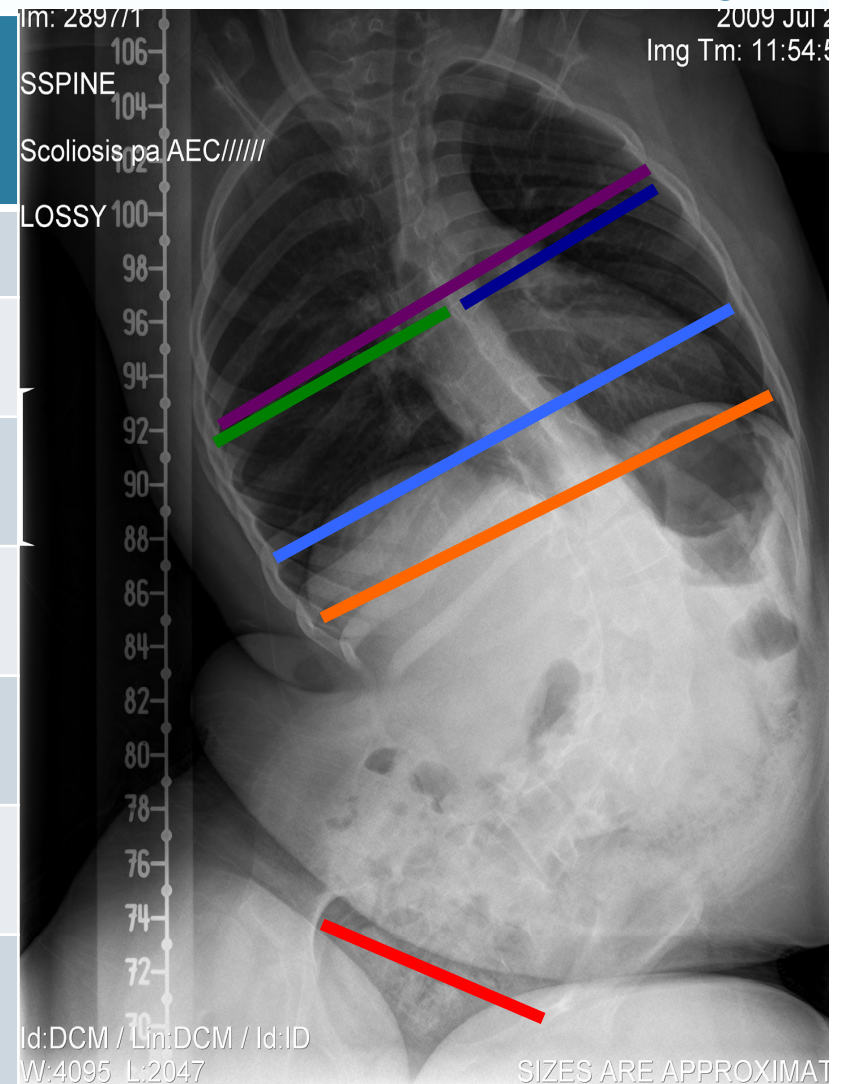
**RVA at apex**



# Describing Parasol Rib Deformity

**Table 1: Measurements taken to determine most accurate radiographic descriptor of parasol rib deformity.**

Simple Ratios	Complex Ratios
RVA	$(T6_{cv}/T6_{cc}) * (T6/T12)$
$T6/T12$	$(T6_{cv}/T6_{cc}) * (T6/pelvic)$
$Max/pelvic$	
$T12/pelvic$	
$T6/pelvic$	* For each ratio or product, lower = worse deformity, higher = more normal
$T6_{cv}/T6_{cc}$	



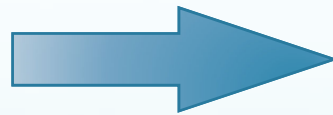
# Statistical Analysis

- Univariate analysis and multivariate logistic regression (backward selection) were applied to identify the ratio most predictive of parasol rib deformity

- T6/T12

- T6/pelvic

- T6cv/T6cc



$$(T6cv/T6cc)*(T6/T12)$$

**= “Parasol Score”**

- $(T6cv/T6cc)*(T6/pelvic)$

- $(T6cv/T6cc)*(T6/T12)$

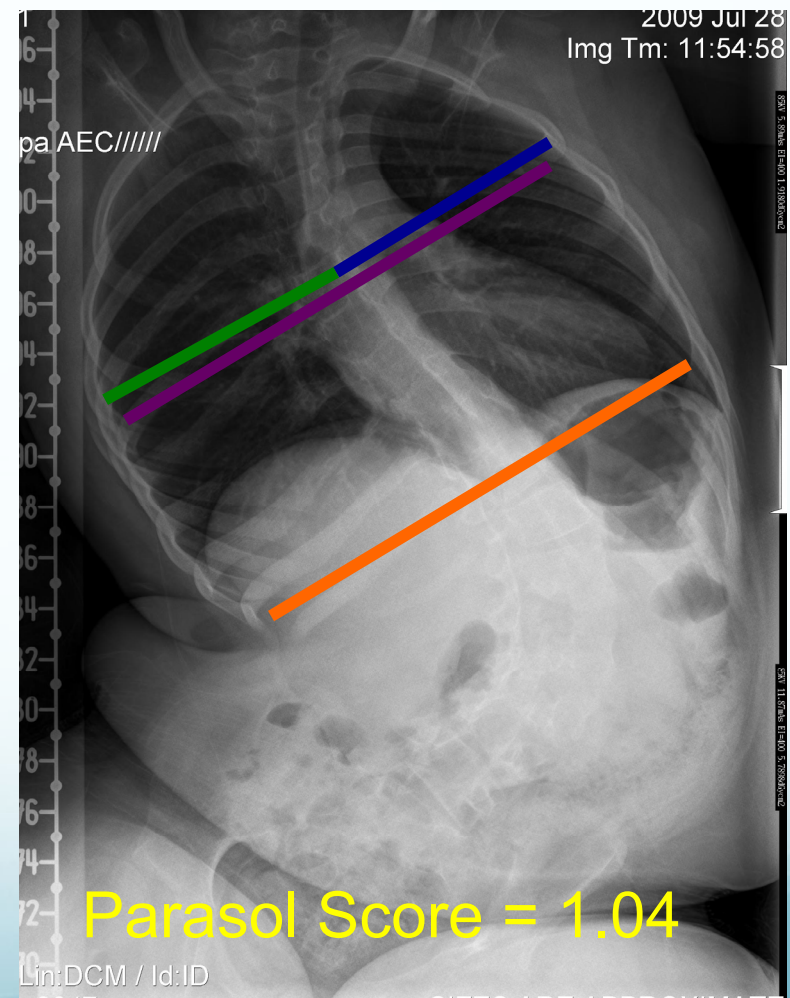
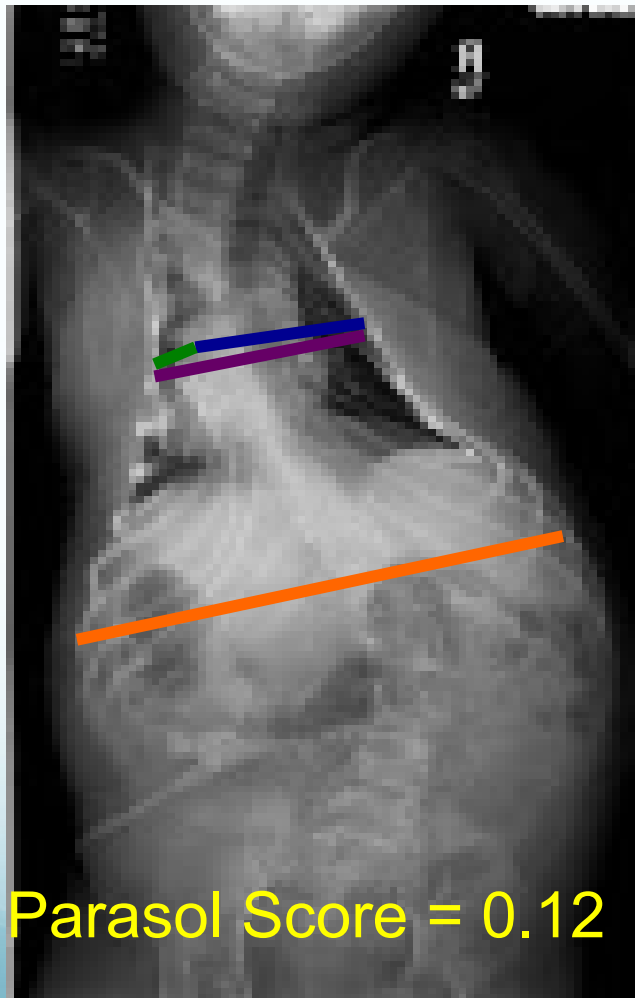


# Statistical Analysis

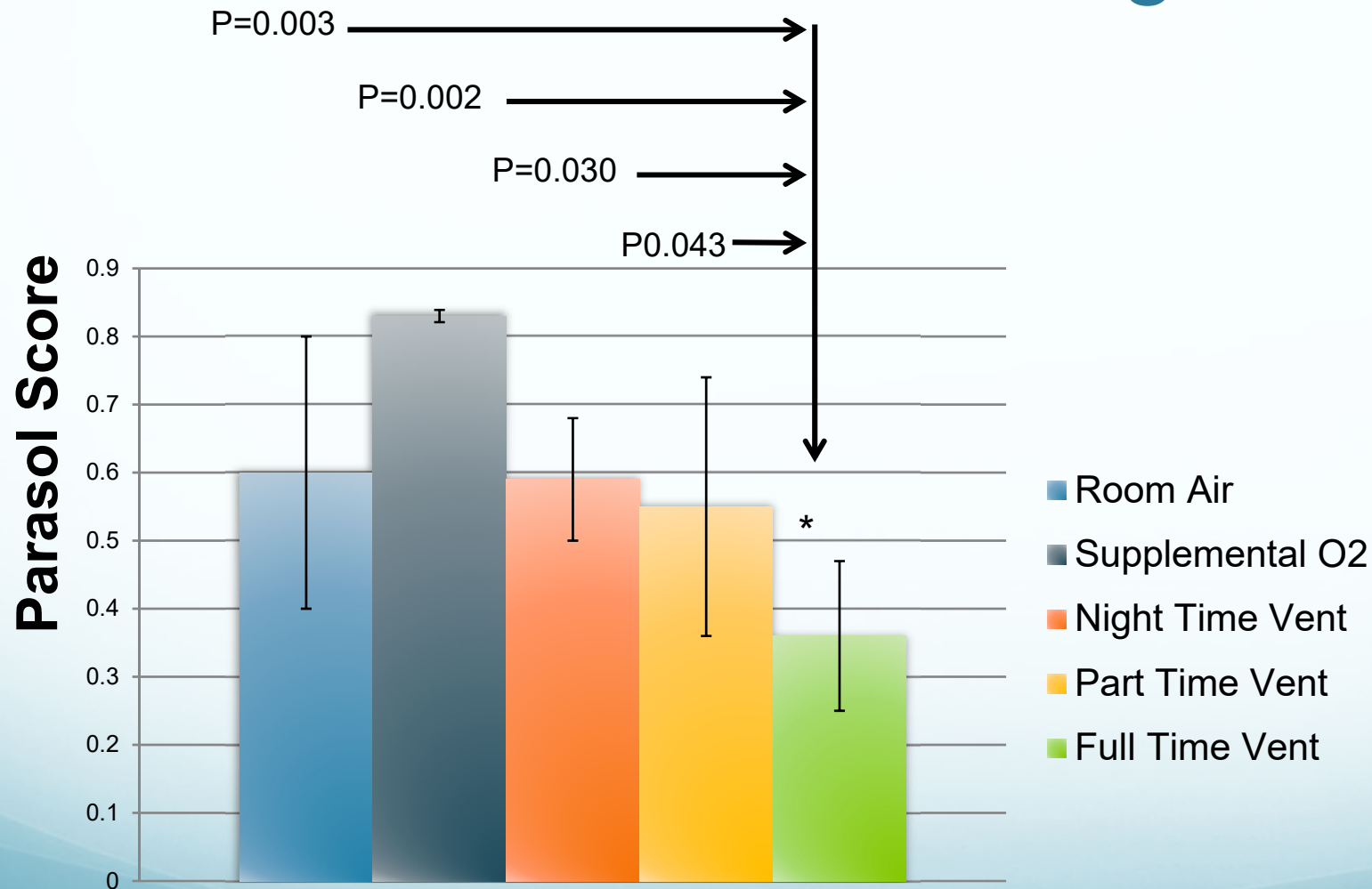
- ROC analysis of Parasol Score
  - AUC = 0.927 (95% CI 0.855-0.998)
- 0.927 = extremely accurate mathematical model of describing parasol rib deformity.
- Youden's J-index → optimal cut-off value
  - Parasol rib deformity  $\leq 0.56$
- Parasol Score  $\leq 0.56$  has sensitivity = 73% and specificity = 100%

## Parasol Score Calculation:

$$(\text{T6cv}/\text{T6cc}) * (\text{T6}/\text{T12})$$



# Parasol score predicts assisted ventilation rating



- Compared with all other AVR's, full time ventilation patients have significantly lower Parasol Scores.

**Table 2. Demographics and Clinical Data Stratified by Type of Instrumentation**

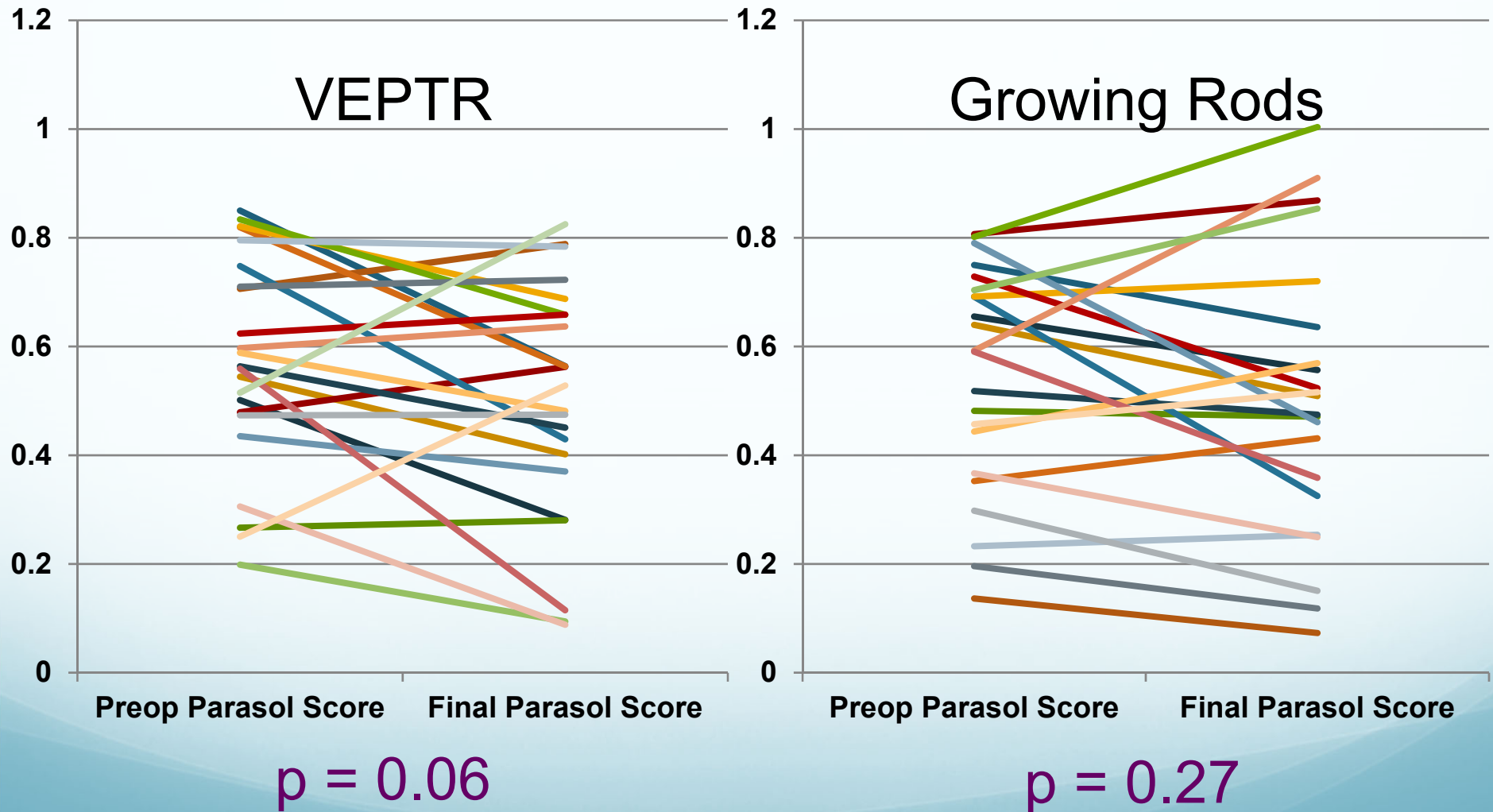
Variable	VEPTR (N = 23)	GR (N = 22)	P value
Age at index, yrs	6.7 ± 2.1	7.7 ± 1.7	0.08
Gender			0.36
Female	12 (52%)	15 (68%)	
Male	11 (48%)	7 (32%)	
Disease			0.75
SMA	11 (48%)	9 (41%)	
Myopathy	5 (22%)	7 (32%)	
Muscular Dystrophy	7 (30%)	6 (27%)	
Follow-up, yrs	3.3 (1.5-8.6)	2.9 (1-10.4)	0.62
# Lengthenings	5 (2-15)	2 (0-13)	<b>&lt;0.001</b>
Complications	83%	41%	<b>0.006</b>

Plus-minus data are mean ± SD compared by Student *t*-test. Gender, instrumentation and disease are compared using Fisher's exact test. Number of lengthenings and follow-up time are median (range) and compared by the nonparametric Mann-Whitney *U*-test.

**Table 3. Radiographic Measurements Stratified by Type of Instrumentation**

Variable	VEPTR (N = 23)	GR (N = 22)	P value
Cobb angle, deg			
Preoperative	63 ± 22	93 ± 22	<0.001
Final follow up	52 ± 21	50 ± 23	0.75
Change in Cobb	-11 ± 23	-43 ± 21	<0.001
Kyphosis, deg			
Preoperative	53 ± 21	59 ± 32	0.61
Final follow up	51 ± 23	39 ± 18	0.07
Change in kyphosis	-2 ± 19	-23 ± 23	0.002
Parasol Score			
Preoperative	0.57 ± 0.20	0.54 ± 0.21	0.61
Final follow up	0.50 ± 0.22	0.50 ± 0.26	0.96
Change in Score	-0.08 ± 0.18	-0.04 ± 0.16	0.50

# Paired Samples Testing





# Conclusion

- Parasol Rib Deformity can now be defined as:

$$\text{Parasol Score} = (\text{T6cv/T6cc}) * (\text{T6/T12})$$

- Can be used to follow parasol deformity over time
  - **Is correlated with Assisted Ventilation Rating**
- **Parasol deformity did NOT improve** over time with either type of implant.
- There was a trend towards worsening parasol deformity in VEPTR patients.

Thank you