

Dual Rods and Submuscular Rod Placement Reduce Complications and Unplanned Surgeries in the Growing Spine: Analysis of 910 Surgeries in 143 Patients

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*2nd International Congress
Early Onset Scoliosis and Growing Spine*
Montreal

November 2008

2nd International Congress on

**Early Onset Scoliosis
& Growing Spine**

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2nd International Congress on

**Early Onset Scoliosis
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(a) Grants/Research Support

(b) Consultant

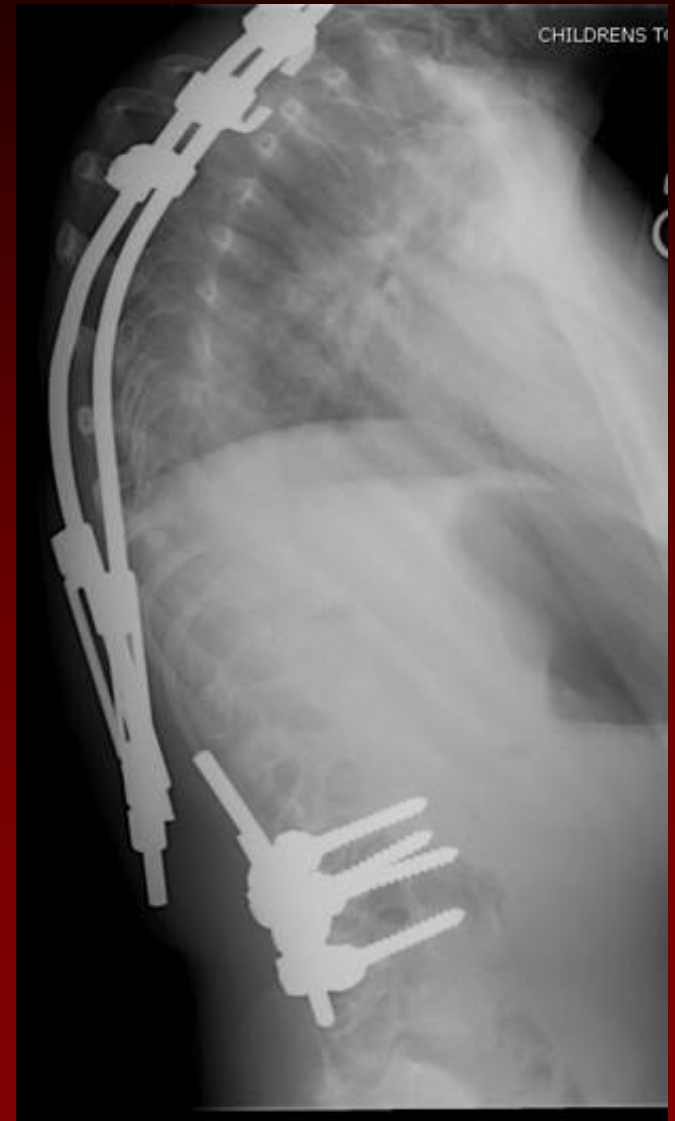
(c) Stock/Shareholder

(d) Speakers' Bureau

(e) Other Financial Support

Introduction

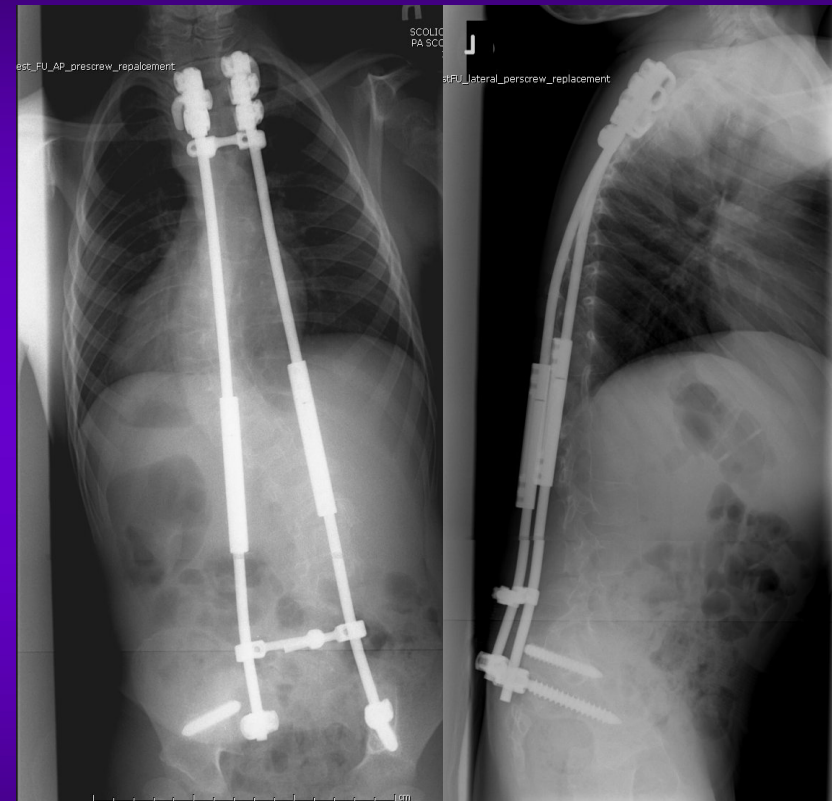
- Treatment Scoliosis Growing Spine= Challenging
- Observation
 - Curve progression
 - Arrest pulmonary development
- Cast treatment
 - Skin breakdown
 - Inhibit chest wall development
- Early Fusion
 - Inhibit trunk and thoracic development
- Fusionless Technology
 - Allow thoracic and pulmonary development
- Growing Rod Technique (GR)
 - Unacceptably high complication rates?



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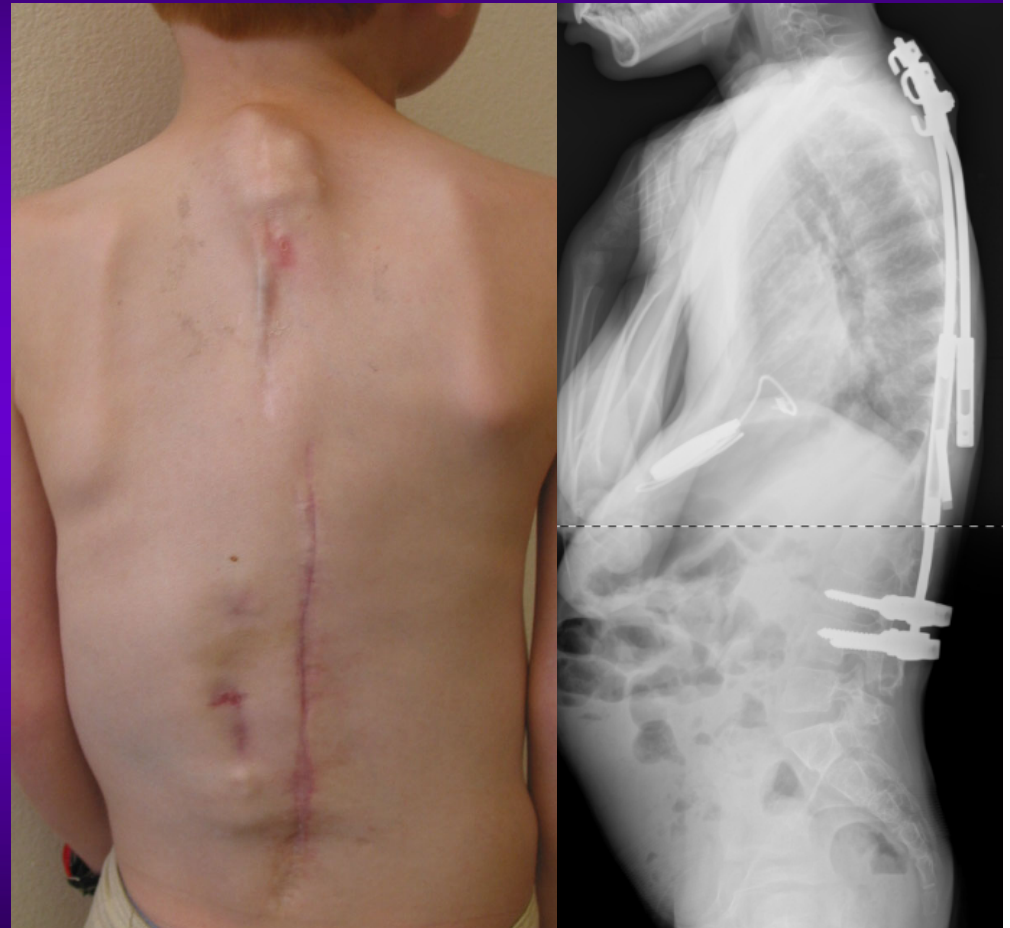
Materials and Methods

- Complications
 - Wound (superficial, deep infection, etc)
 - Implant (rod/fixation failure, prominence, etc)
 - Alignment (curve progression, PJK, DJK, etc)
 - Medical/Other (GI, pulmonary, etc)
- Surgical procedures
 - Planned (PLAN = anticipated surgery due to routine GR treatment)
 - Unplanned (UNPLAN= surgery due to complications)

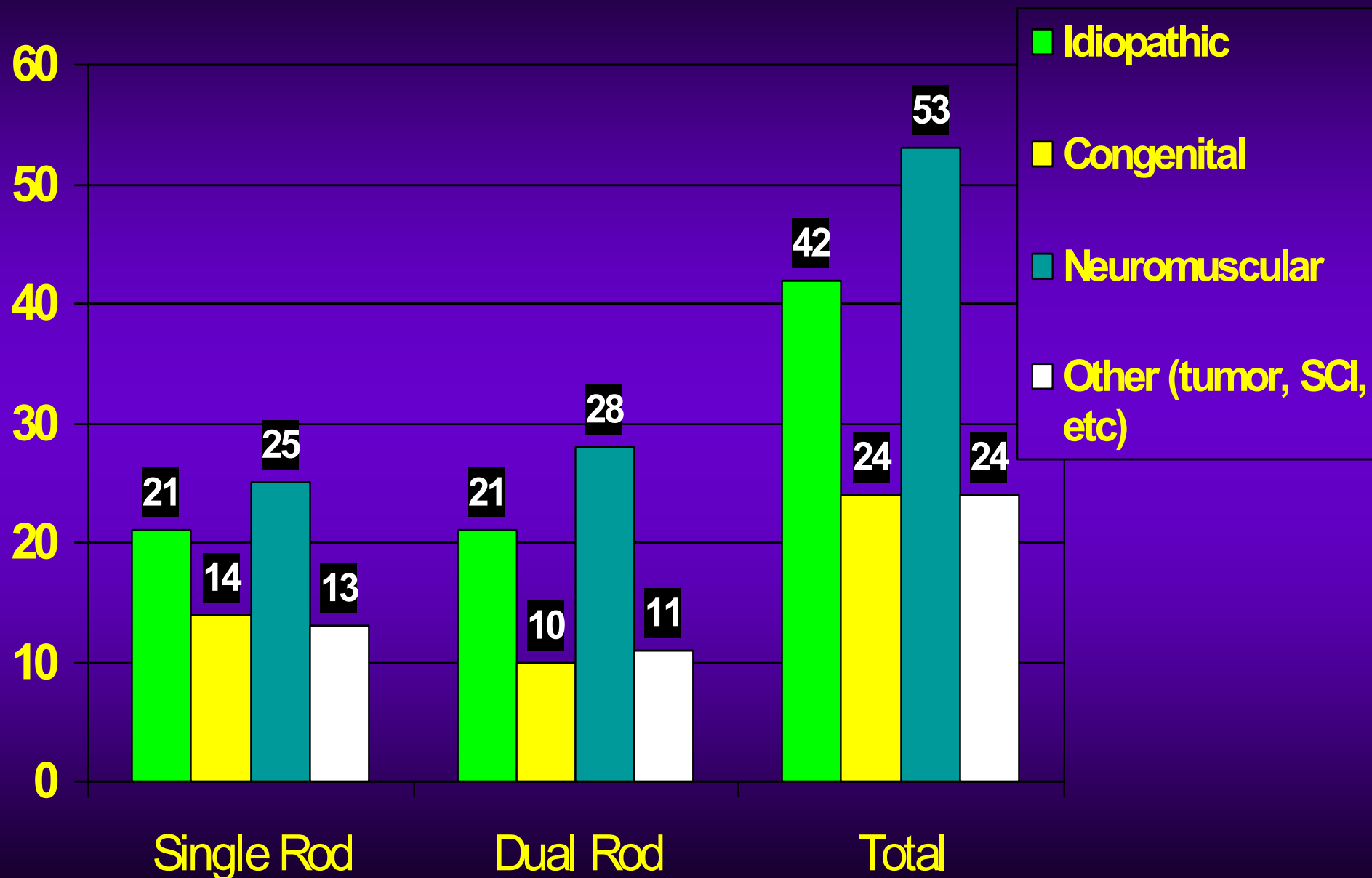


Results: Demographics & Treatment Groups

- 143 patients (1987-2005)
- Avg. age =6.1 years (range, 1.6-12 yrs)
- 910 GR surgeries
 - 13.3 levels (7-18)
 - 6.4 procedures/ pt (2-15)
 - 4.5 lengthening/ pt (0-13)
 - Final fusion=53 pts (37%)
- Follow up=59.4 mo. (24-166 mo.)
- Treatment groups
 - Construct type (NS)
 - SI; n=73
 - DU; n=70
 - Subgroups (*= $p < 0.05$)
 - SI SQ; n=17*
 - SI MU; n=55
 - DU SQ; n=35
 - DU MU; n=35



Results: Diagnosis



Results: Total Procedures and Complications

Single vs. Dual Rod	SI (n=73)	DU (n=70)	p value	Total (n=143)
Total Surgeries; avg (range)	447; 6.1 (3-13)	463; 6.6 (2-15)	NS	910; 6.4 (2-15)
Total complications	94	83	NS	177
Total pts with complication	43	38	NS	81
Percent pts with complication	59%	54%	NS	57%
Complications per patient (range)	1.3 (0-7)	1.2 (0-7)	NS	1.2 (0-7)
Complications per surgery	0.21	0.18	NS	0.19
Total UNPLAN	42	32	NS	74
Total PLAN	405	431	NS	836
Ratio PLAN to UNPLAN	9.6:1	13.5:1	NS	11.3:1
Complications leading to UNPLAN	45%	38%	NS	42%

Results: Wound Complications

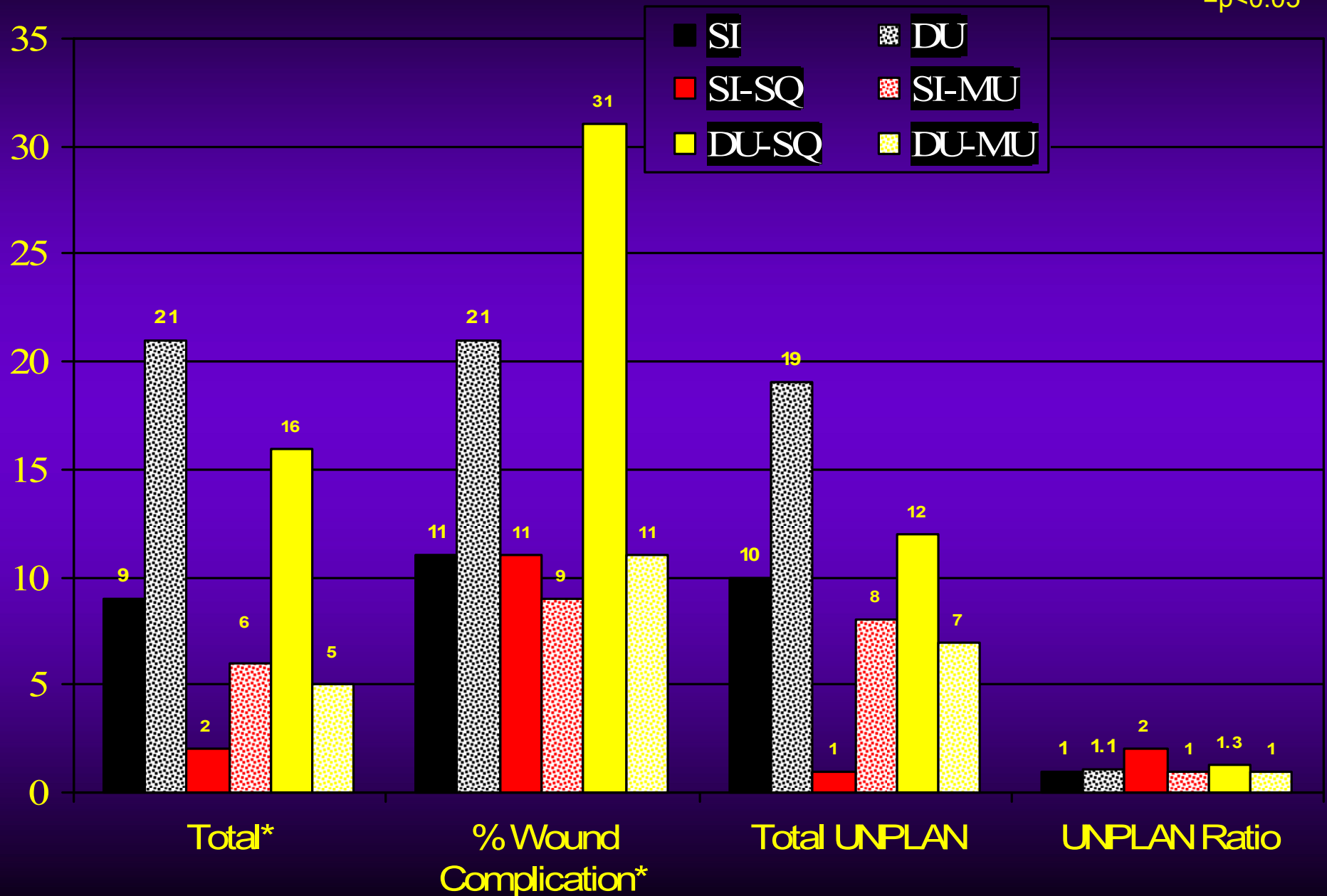
	SI (n=73)	DU (n=70)	Total (n=143)
Total Wound Complications (pts;total;avg)	8;9;0.12	15;21;0.3	23;30;0.21
% Wound Complication	11%	21%	16%
Superficial; Deep Infections	0* ; 6	6* ; 8	6; 14
UNPLAN (pts;total)	7;10	9;19	16;29
Ratio Wound Problem: UNPLAN	<1	1.1	1.03

	SI-SQ (n=17)	SI-MU (n=55)	DU-SQ (n=35)	DU-MU (n=35)
Total Wound Complications (pts;total;avg)	2;2;0.12	5;6;0.11	11* ;16;0.5	4* ;5;0.1
% Wound Complication	11%	9%	31%*	11%*
Superficial; Deep Infections	0;1	0; 4	4; 6	2; 3
UNPLAN (pts/total)	1;1	5;8	5;12	4;7
Ratio Wound Problem: UNPLAN	2	<1	1.3	<1

***=p<0.05**

Results: Wound Complications

*=p<0.05

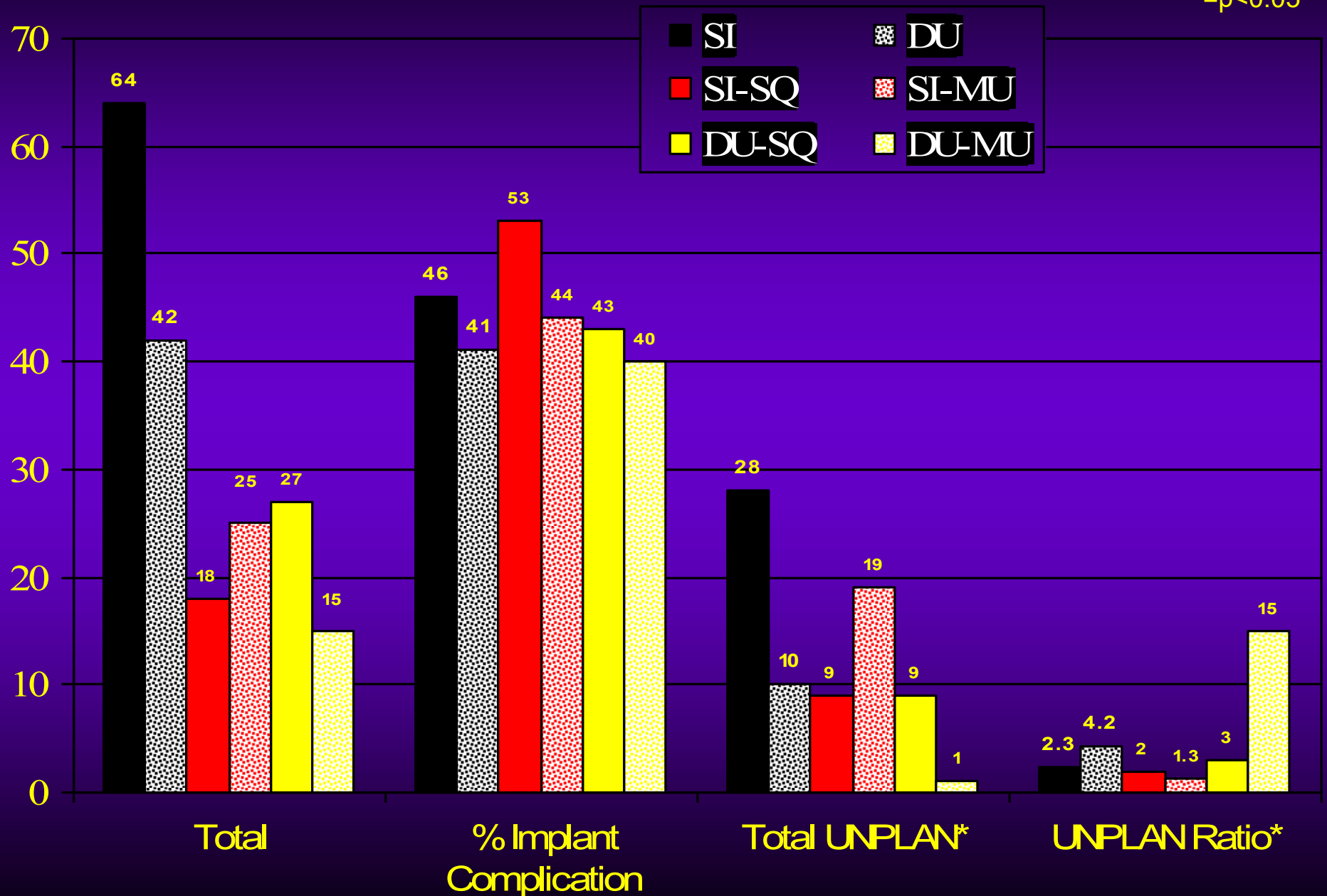


Results: Implant Complications

	SI (n=73)	DU (n=70)	Total (n=143)	
Total Implant Complications (pts;total;avg)	34;64;0.88	29;42;0.6	63;106;0.74	
% Pts Implant Complication	46%	41%	44%	
Hook Loss; Screw Loss; Rod Fracture; Prominence; (total)	27*; 0; 30; 2	10*; 5; 22; 4	37; 5; 52; 6	
UNPLAN (pts;total;avg)	19*;28*;0.4*	7*;10*;0.15*	26;38;.28	
Ratio Implant Problem: UNPLAN	2.3	4.2	2.8	
	SI-SQ (n=17)	SI-MU (n=55)	DU-SQ (n=35)	DU-MU (n=35)
Total Implant Complications (pts;total;avg)	9;18;1.1	24;25;0.8	15;27;0.8	14;15;0.4
% Pts Implant Complication	53%	44%	43%	40%
Hook Loss; Screw Loss; Rod Fracture; <u>Prominence</u> ; (total)	8; 0; 7; 1	19; 0; 22; 1	6; 5; 11; 4*	4; 0; 11; 0*
UNPLAN (pts;total;avg)	6;9;0.5	12;19;0.4	6*;9*;0.3*	1*;1*;0.03*
Ratio Implant Problem: UNPLAN	2	1.3	3	15*
*=p<0.05				

Results: Implant Complications

*=p<0.05



Results: Alignment Complications

	SI (n=73)	DU (n=70)	Total (n=143)
Total Alignment Complications (pts;total;avg;range)	4; 4; 0.05; 0-1	6; 7; 0.1; 0-2	10; 11; 0.08; 0-2
% Pts with Alignment Complication	6%	9%	7%
Junctional Kyphosis; Curve Progression; Other; (total)	1; 0; 3	2; 4; 0	3; 4; 3
UNPLAN (pts;total;avg;range)	3; 3; 0.04; 0-1	2; 3; 0.04; 0-2	5; 6; 0.04; 0-2
Ratio Implant Problem: UNPLAN	1.3	2.3	1.8

***=p<0.05**

	SI-SQ (n=17)	SI-MU (n=55)	DU-SQ (n=35)	DU-MU (n=35)
Total Alignment Complications (pts;total;avg;range)	2;2; 0.12; 0-1	1;1; 0.02; 0-1	3;3; 0.09; 0-1	3;4; 0.1; 0-2
% Pts with Alignment Complication	12%	2%	8%	8%
Junctional Kyphosis; Curve Progression; Other; (total)	0; 0; 2	1; 0; 0	1; 1; 1	1; 3; 0
UNPLAN (pts;total;avg;range)	2;2; 0.12; 0-1	0	1; 1; 0.03; 0-1	1; 2; 0.06; 0-2
Ratio Implant Problem: UNPLAN	1	NA	3	1

***=p<0.05**

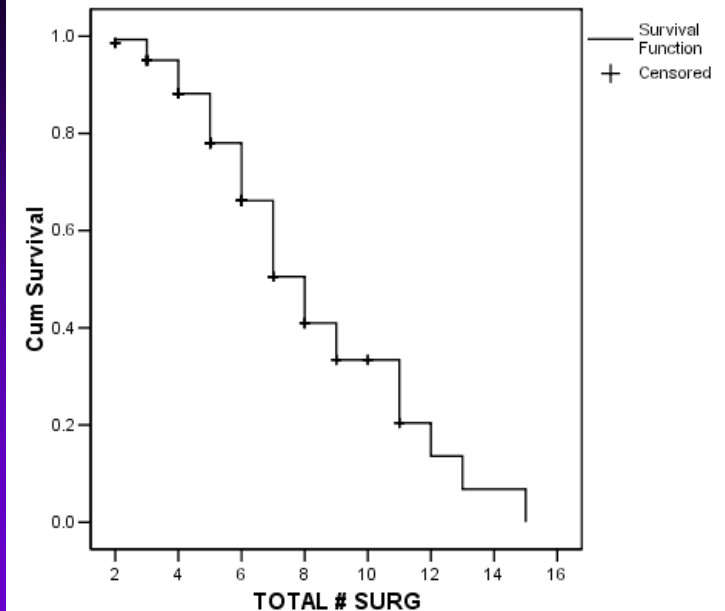
Results: Medical and Other Complications

	SI (n=73)	DU (n=70)	Total (n=143)
Total Medical & Other Complications (pts;total;avg;range)	11; 15; 0.21; 0-2	6; 7; 0.1; 0-3	17; 22; 0.15; 0-3
% Pts with Medical Complication	15%	8%	12%
Pulmonary	8	2	10
Dural Tear	3	1	4
Other (hematoma, GI, EBL)	4	4	8
UNPLAN	0	0	0
Ratio Implant Problem: UNPLAN	NA	NA	NA

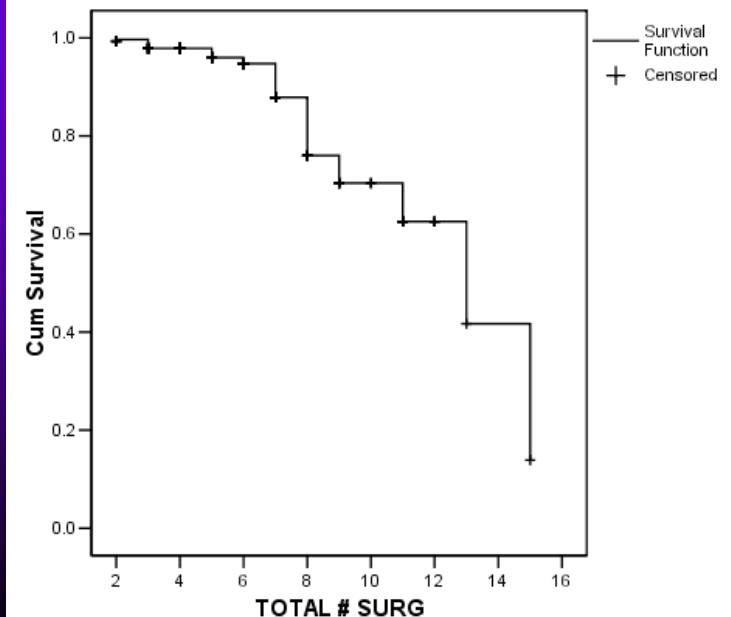
Results

- Kaplan-Meier Survival Analysis
- Total complications vs. Procedures
 - 50% survivorship at 7 surgeries
- Wound Complications vs. Procedures
 - 90% survivorship at 7 surgeries
 - 40% survivorship at 13 surgeries
- Odds Ratio: Complication vs. Procedure
 - 24% increased complication risk each additional procedure
 - (Odds Ratio=1.24, 95% Confidence Interval: 1.07, 1.44, $p=0.005$)
- Odds Ratio: Complication vs. Age
 - 13% decrease complication risk each year increased age initial surgery
 - (Odds Ratio=0.87, 95% Confidence Interval: 0.75, 1.00, $p=0.057$).

Survival Function - Overall complications

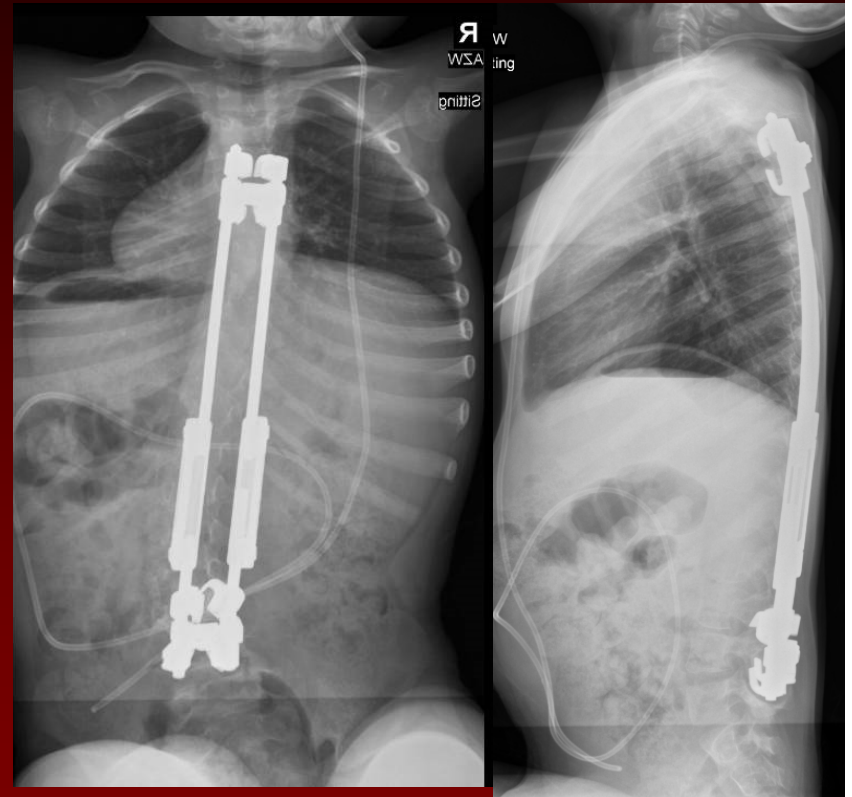


Survival Function - Wound complications



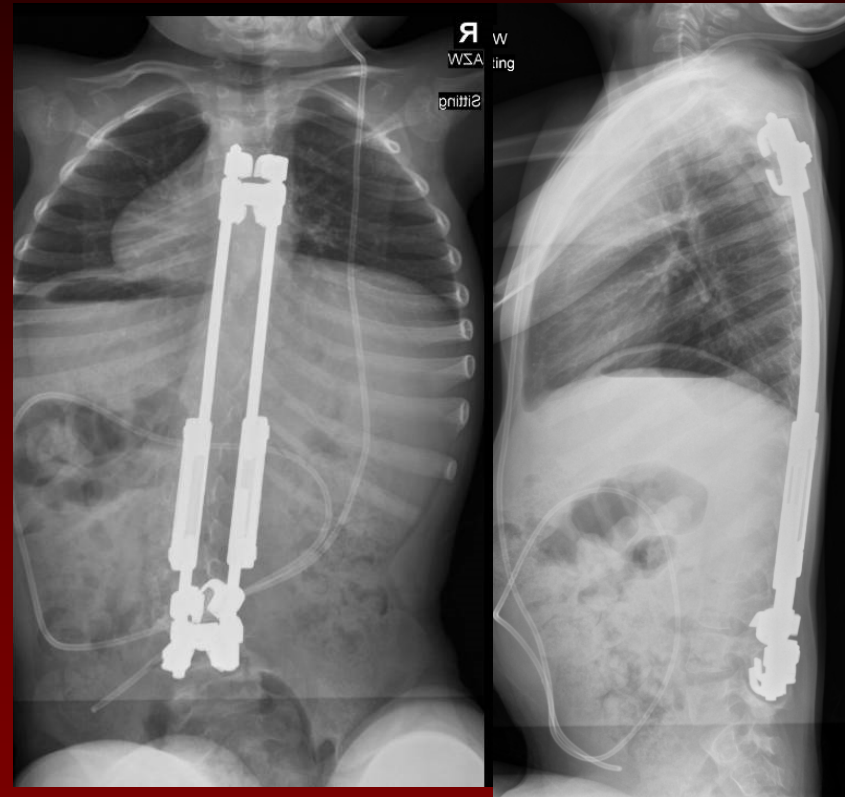
Conclusions

- Growing Rod Complications
 - Procedure vs. Treatment
 - Acceptable complication rate per procedure?
 - Comparable to AIS (Carreon et al JBJS 2007)
 - 19% vs. 15.4%
- Complication rate correlates with number procedures
 - Anticipate complication
 - Council parents



Conclusions

- Complications $\neq$ Surgery
- Complications manageable by PLAN
- Steps to minimize
 - Complications
 - UNPLAN
- Dual Rods
 - Reduce implant complications
 - Reduce implant UNPLAN
- Submuscular Rods
 - Reduce wound complications



Thank You

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