The Effect of Traditional Single Growing Rod Technique on Growth of Unsegmented Levels in Mixed Type Congenital Scoliosis

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No Disclosure

Nov. 22, 2019

ICEOS, Atlanta, US

BACKGROUND

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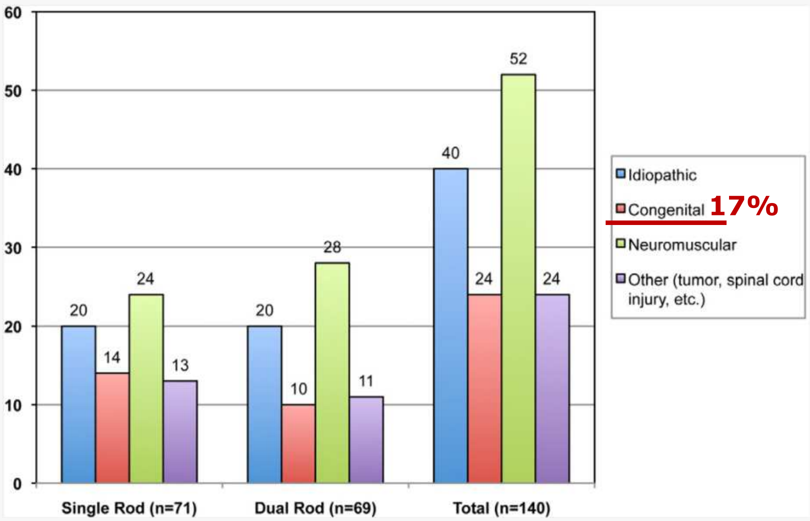
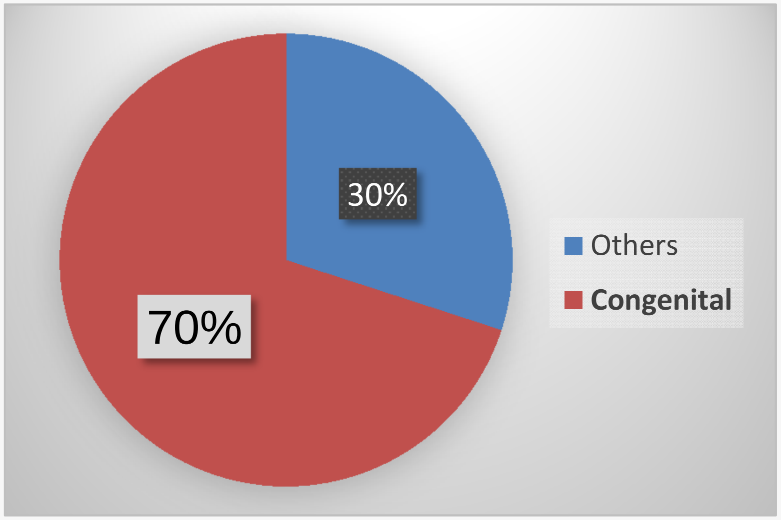
Significantly higher percentage of congenital EOS in Asian population



Growing Spine Study Group database

CS



Unpublished data from PUMCH, China

Bess S, Akbarnia BA, Thompson GH et al. J Bone Joint Surg Am. 2010 Nov 3;92(15):2533-43

BACKGROUND

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Traditional single growing rod **(SGR)** in congenital scoliosis **(CS)**

Safety and Efficacy of Growing Rod Technique for Pediatric Congenital Spinal Deformities

Hazeem B. Elsebai, MD, Muharrem Yazici, MD, George H. Thompson, MD, John B. Emans, MD, David L. Skaggs, MD, Alvin H. Crawford, MD, Lawrence I. Karlin, MD, Richard E. McCarthy, MD, Connie Poe-Kochert, RN, Patricia Kostial, RN, and Behrooz A. Akbarnia

19 CS patients (**12 single rod**)

- Cobb angle: 66° → 47°
- T1-S1 growth: 11.7 mm/year
- Complication: 42% (8/19)

Minimizing Complications With Single Submuscular Growing Rods

A Review of Technique and Results on 88 Patients With Minimum Two-Year Follow-up

18 CS patients treated with SGR

- Cobb angle: 70° → 44°
- T1-S1 growth: 8.4 mm/year
- Complication: 50% (9/18)

Elsebai HB, Yazici M, Thompson GH et al, J Pediatr Orthop. 2011 Jan-Feb;31(1):1-5
Farooq N, Garrido E, Altaf Fet al, Spine (Phila Pa 1976). 2010 Dec 1;35(25):2252-8

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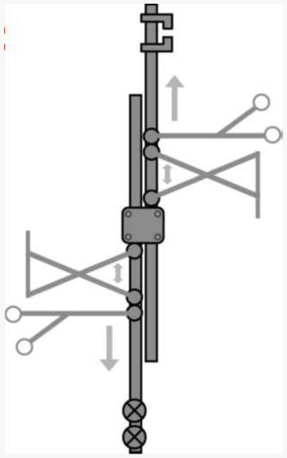
CS with segmentation failure

Literatues regarding on nature history of mixed type CS:

- Limited or even no growth in unsegmented levels (USLs)
- Treatment options: shortening (osteotomy, fusion etc.)

Questions:

- **Could the unsegmented spine be lengthened?**
- **How would SGR affect the spine growth in CS patients with extensive segmentation failure?**



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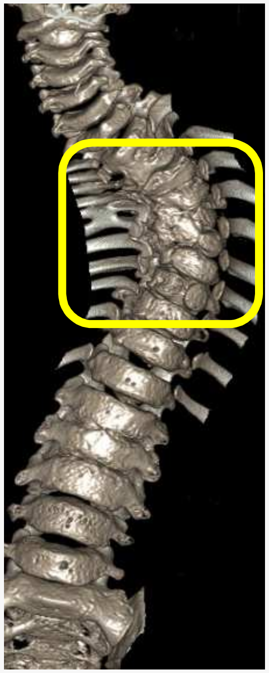

METHODS

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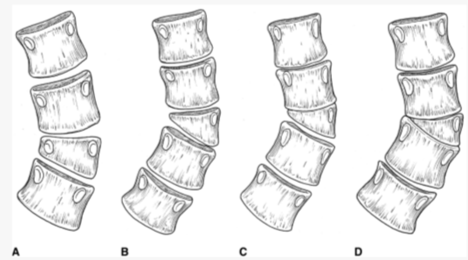
Study Design

- Retrospective, single-center, case series study

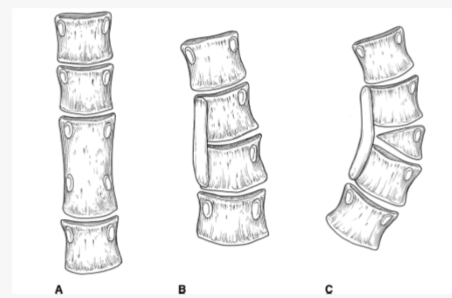
Included Criteria

Early-onset mixed-type congenital scoliosis **(EOMTCS)**

- Initially treated by **SGR**
- At least **4 USLs** around apex
- At least **4 distractions** and **3-year follow-up**



Mixed-type: combination of both



Hedequist D and Emans J. J Am Acad Orthop Surg. 2004 Jul-Aug;12(4):266-75

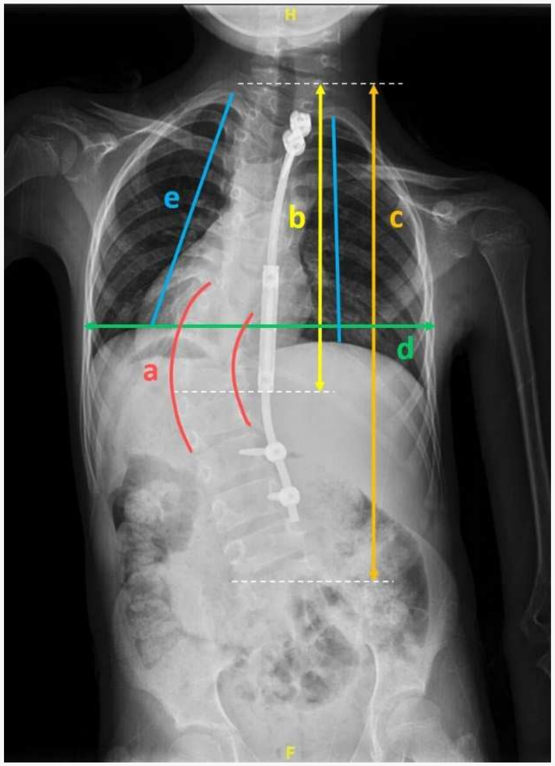
METHODS

Clinical Data

- Demographic and operative data
- Nutritional status: BMI, hemoglobin

Radiograph Measurement

- AP and L film (before implantation and at the latest follow-up)
- Length of **concave and convex side of the USLs**
- Thoracic parameters, all spine height and SAL



Mayer O, Campbell R, Cahill P, et al. Curr Probl Pediatr Adolesc Health Care. 2016 Mar;46(3):72-97

RESULTS

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Demographic data of the 12 enrolled patients

Pt. No.	Age at index surgery (yr)	Sex	USLs	Unilateral bar	Fused ribs on concave side	Cobb angle of major curve (°)	Intraspinal anomalies	Additional comorbidities
1	7.6	F	T7-T11	T9-T10	No	78	SCM (Type I)	No
2	6.6	M	T8-T11	T8-T11	No	82	No	Congenital eventration of right diaphragm
3	3.4	F	T7-T11	T7-T11	T5-T6	104	No	Klippel-Feil syndrome, bicuspid aortic valve
4	6.9	F	T2-T8	No	T5-T8	90	No	No
5	10.7	M	T5-T11	T7-T10	T4-T8	106	SCM (Type I), tethered cord, syringomyelia	Thoracic insufficiency syndrome
6	4.5	M	T11-L1	No	No	100	No	No
7	7.0	F	T6-T9	T8-T9	T6-T7, T8-T9	81	SCM (Type I)	No
8	10.2	M	T3-T11	T8-T11	No	95	No	No
9	9.2	M	T3-T11	No	T4-T10	119	Syringomyelia, tethered cord	Thoracic insufficiency syndrome
10	12.3	F	T2-T11	No	T4-T9	104	SCM (Type II), tethered cord	Thoracic insufficiency syndrome
11	8.9	F	T8-L1	T9-L1	No	68	Syringomyelia	No
12	4.0	F	T1-T9	T4-T8	T5-T6	85	SCM (Type II), tethered cord	No
ALL	**7.6±2.8**	**-**	**6.6±2.3**	**8/12**	**7/12**	**93±15**	**7/12**	**5/12**

Pt. No., patient number; *USLs*, unsegmented levels; *SCM*, split cord malformation.

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Operative data of the 12 enrolled patients

Pt. No.	Previous surgery	Index surgery			Number of distractions	Final fusion	Graduation	IONM alert*	Duration of follow-up (yr)
		Diameter of rod	Proximal anchor	Distal anchor					
1	Anterior spinal release	5.5mm	T4 (H), T5 (H)	L4 (S)	4	Yes	Yes	No	5.7
2	Anterior epiphysiodesis	5.5mm	T3 (H), T4 (H)	L4 (S)	4	Yes	Yes	No	6.8
3	No	5.5mm	T2 (H), T3 (H)	L4 (S)	4	Yes	Yes	No	5.0
4	No	4.5mm	T1 (H), T11 (S)	T11 (S), L4 (S)	8	No	Yes	No	6.3
5	No	5.5mm	T2 (S), T3 (S)	L3 (H), L4 (H)	7	Yes	Yes	No	4.1
6	No	4.5mm	T8 (S), T9 (S)	L3 (S), L4 (S)	8	No	No	No	6.9
7	No	5.5mm	T3 (S), T4 (S)	T12 (S), L1 (S), L2 (S)	10	Yes	Yes	Yes	5.7
8	No	4.5mm	T2 (S), T3 (S)	L3 (S), L4 (S)	5	No	No	No	3.5
9	No	4.5mm	T2 (S)	L1 (S), L2 (S)	6	No	No	Yes	4.4
10	No	4.5mm	C7 (S), T1 (S)	L3 (S), L4 (S)	5	No	No	No	3.2
11	No	4.5mm	T2 (S), T3 (S)	L2 (S), L3 (S)	4	No	No	No	3.1
12	Osseous spur resection	4.5mm	C7 (S)	T12 (S), L1 (S)	4	No	No	No	3.0
ALL	**3/12**	**-**	**-**	**-**	**5.8±2.1**	**5/12**	**6/12**	**2/12**	**4.8±1.5**

Pt. No., patient number; *IONM*, intraoperative neuromonitoring; *(H)*, lamina hook; *(S)*, pedicle screw. *At index surgery.

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Radiographic measurement of the concave and convex sides at the unsegmented levels

Pt. No.	Length of **concave** side of unsegmented levels (**intervention** group, mm)						Length of **convex** side of unsegmented levels (**control** group, mm)					
	Baseline	Follow-up	Total growth		Annual growth		Baseline	Follow-up	Total growth		Annual growth	
			Value	Percentage	Value	Percentage			Value	Percentage	Value	Percentage
1	61	80	19	31.1	3.4	5.5	95	101	6	6.3	1.1	1.1
2	33	52	19	57.6	2.8	8.5	63	92	29	46.0	4.3	6.8
3	34	57	23	67.6	4.5	13.5	55	78	23	41.8	4.6	8.4
4	65	85	20	30.8	3.2	4.9	127	137	10	7.9	1.6	1.3
5	88	163	75	85.2	18.2	20.7	143	176	33	23.1	8.0	5.6
6	42	58	16	38.1	2.3	5.5	70	84	14	20.0	2.0	2.9
7	43	59	16	37.2	2.8	6.5	84	101	17	20.2	3.0	3.5
8	110	144	34	30.9	9.8	8.9	155	171	16	10.3	4.6	3.0
9	59	91	32	54.2	7.3	12.3	107	142	35	32.7	7.9	7.4
10	103	127	24	23.3	7.5	7.2	177	184	7	4.0	2.2	1.2
11	58	65	7	12.1	2.3	3.9	99	102	3	3.0	1.0	1.0
12	69	86	17	24.6	5.6	8.2	112	120	8	7.1	2.7	2.4
Mean	-	-	-	**41.1±21.0***	-	**8.8±4.7***	-	-	-	**18.5±14.9***	-	**3.7±2.7***

Pt. No., patient number; *The **concave side** had a significantly **higher total and annual growth** (paired t-test, $P < 0.001$).

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Follow-up results of the 12 enrolled patients

Variables	Baseline	Follow-up	P value*
Radiograph measurements			
Cobb angle (°)	89.7±19.6	66.8±20.9	<0.001
T1-T12 height (mm)	142.8±26.4	179.0±28.2	<0.001
T1-S1 height (mm)	256.2±45.6	323.3±49.2	<0.001
Thoracic width (mm)	178.4±20.5	200.1±24.6	<0.001
Thoracic depth (mm)	72.6±14.1	95.0±21.3	<0.001
SAL (%)	75.1±11.3	89.0±7.6	<0.001
Nutritional status			
BMI (kg/m^2)	15.9±2.5	19.0±3.7	0.001
Hemoglobin (g/L)	129.9±7.0	134.1±8.6	0.109

SAL, space available for lung; *BMI*, body mass index.

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Implantation related complications

- 66.7% of the patients (8/12)
- 12 cases: anchor failure
- 2 cases: rod breakage
- All managed during lengthening
- 3 patients transferred to DGR

Pt. No.	Implant related complication (No. of cases)		
	Proximal AF	Distal AF	Rod breakage
1	1	1	0
2	1	1	0
3	0	1	0
4	0	0	0
5	1	0	0
6	1	2	1
7	0	2	0
8	0	0	1
9	0	0	0
10	0	0	0
11	0	0	0
12	1	0	0
Total	**5**	**7**	**2**

Pt. No., patient number; *AF*, anchor failure.

RESULTS

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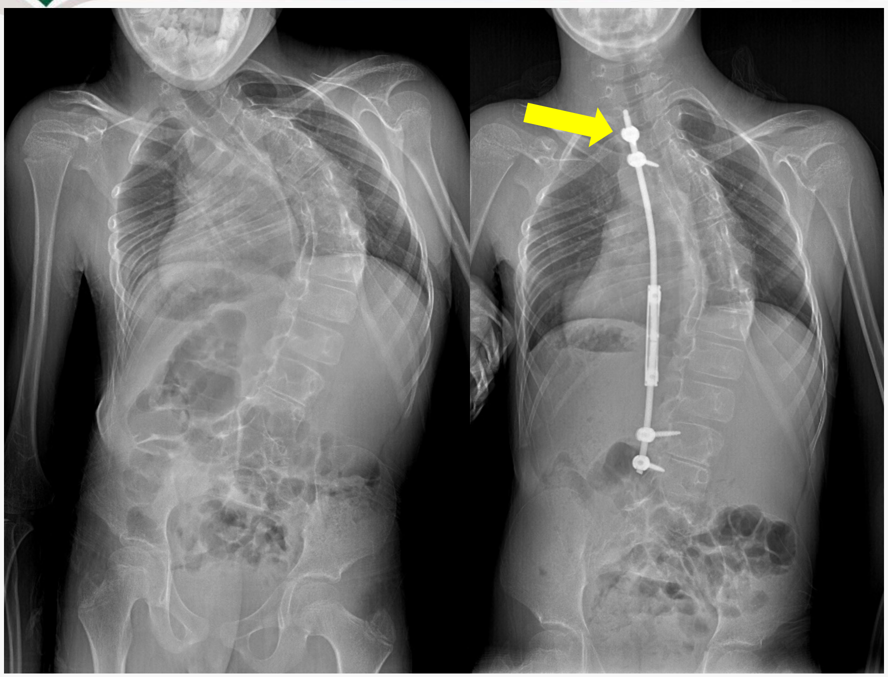
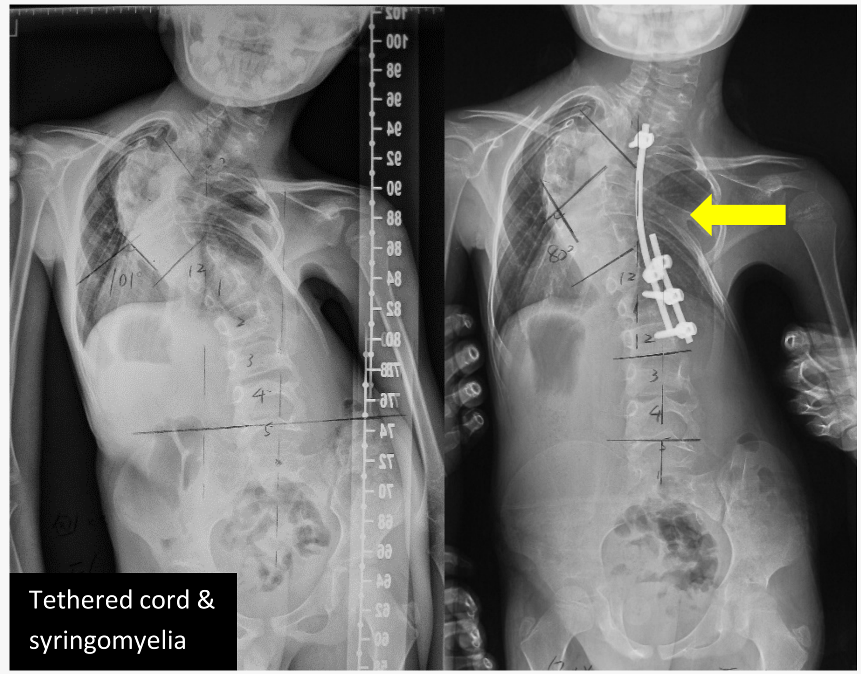


Pre-index Post-index

- 50% decrease of MEP when T2 screw insertion
- Resolved by adjusting the direction of screw



Pre-index Post-index

- 60% decrease of MEP when distraction and correction
- Resolved by observation

CASE 1

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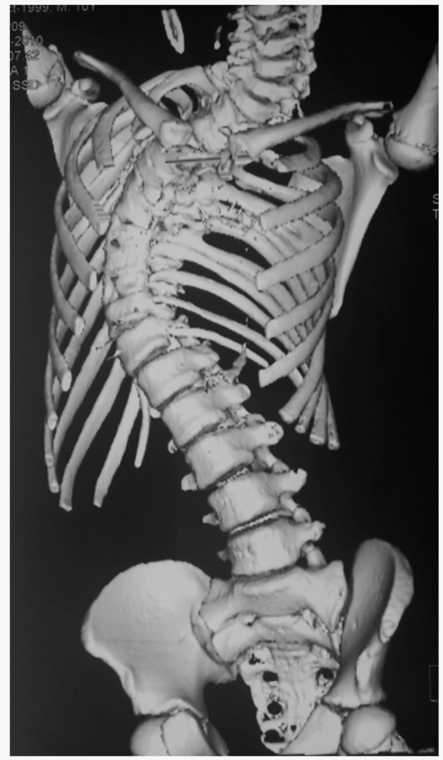
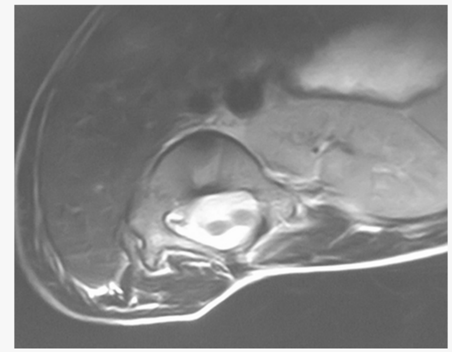
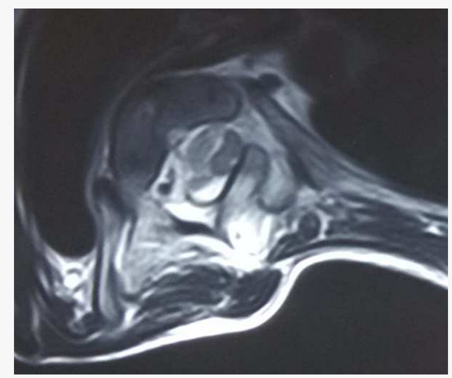
10Y/M, Congenital scoliosis, type II split cord malformation







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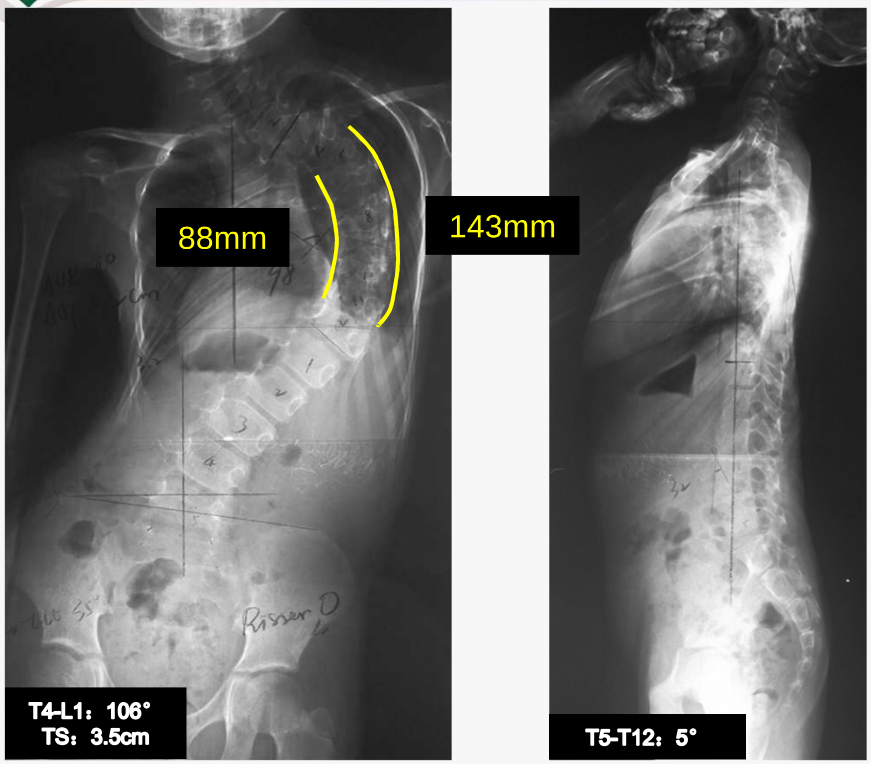
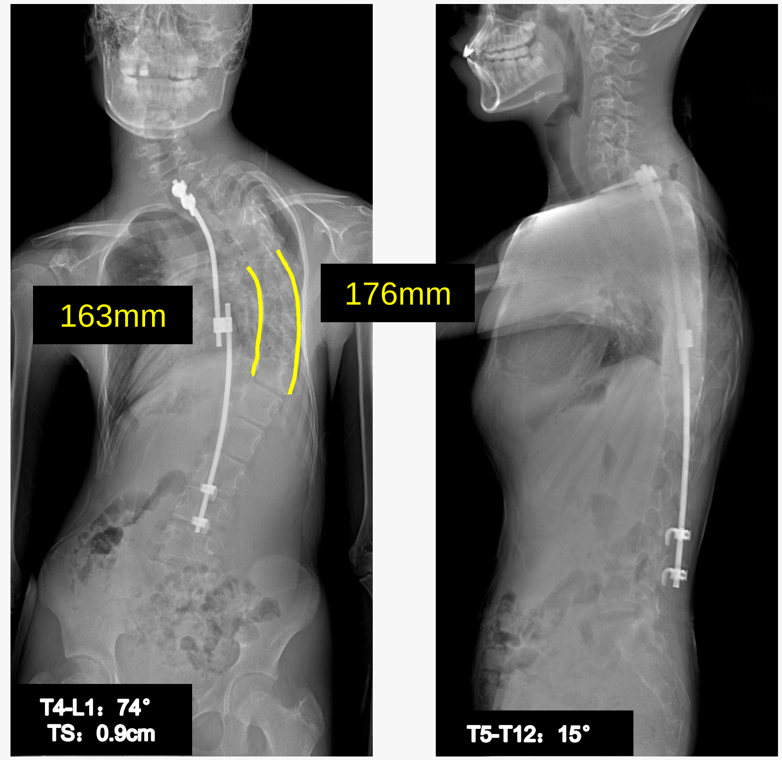


Pre index surgery, T5-T11 segmentation failure, Jun 2010



7th lengthening with fusion, Aug 2014

CASE 2

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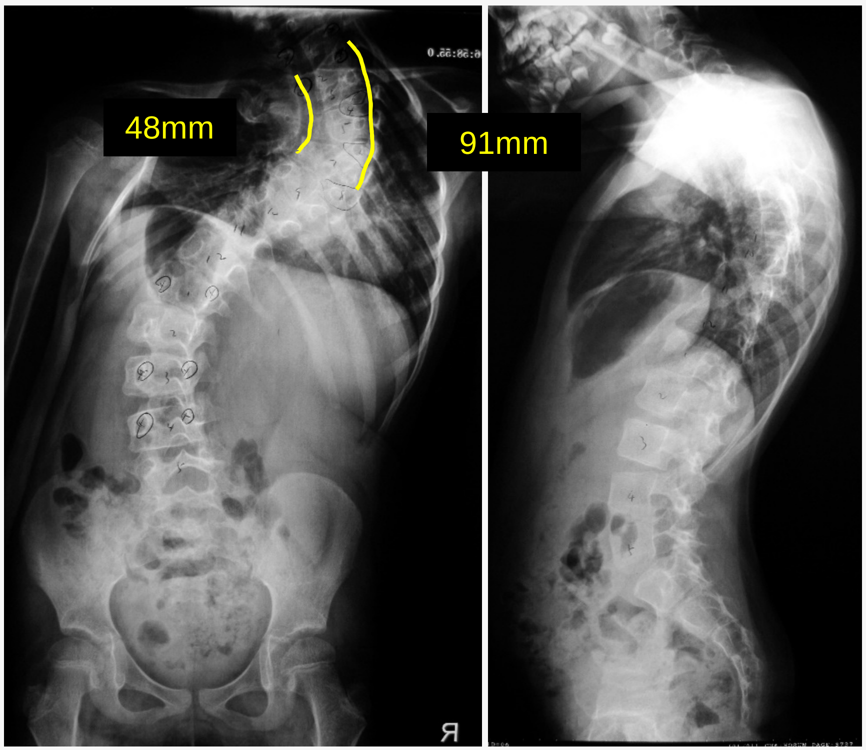
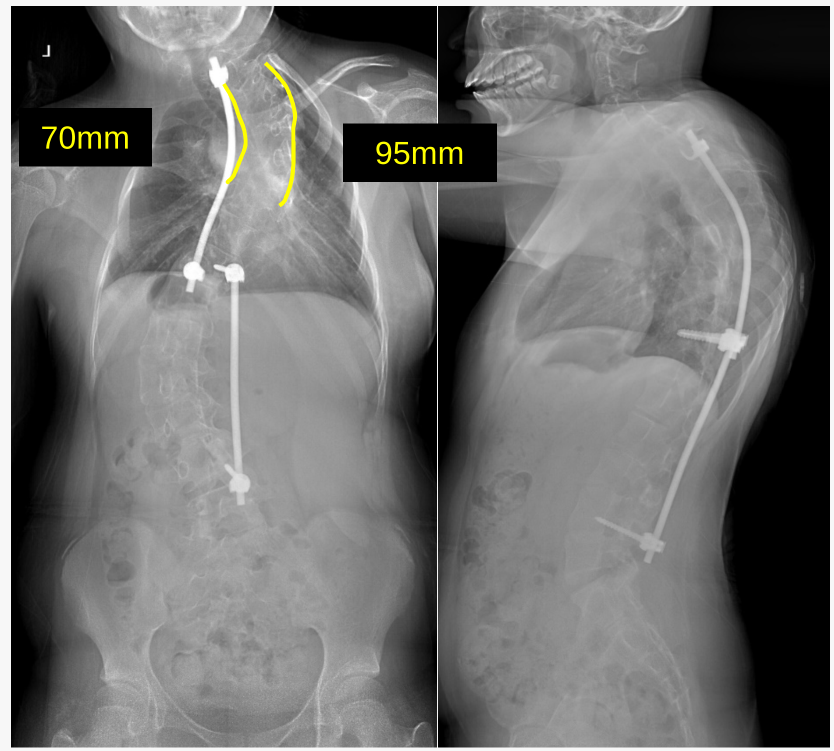
7Y/F, Congenital scoliosis



Pre index surgery, T2-T7 segmentation failure, Mar 2010



Post 8th lengthening, Aug 2015

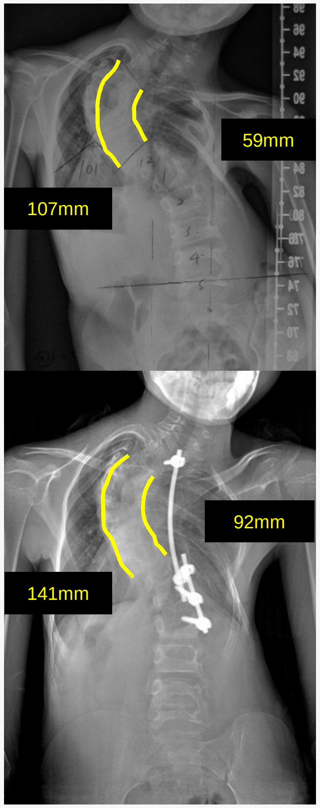
Conclusion

Key finding

- **SGR accelerates the growth of concave side of USLs**

Significances

- **SGR rebalances the growth of USLs by lengthening the concave side**
- **Helpful for spine growth and development of pulmonary function**



Looking Forward

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Single rod TGR or MCGR

- Both intermittent lengthening the concave side and are useful for rebalancing the spine
- But the pediatric spine growth is not intermittent so it may cause **PJK or DJK**

- **Mimic nature growing** of the spine by **Remote Controlled Continued Growing Rod** may improve the treatment of EOS

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Thank you