

# Posterior Corrective Surgery for Type II Congenital Kyphosis: SRS-Schwab Grade 4 Osteotomy or Vertebral Column Resection?

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**Objective.** To compare the radiographic and clinical outcomes between SRS-Schwab Grade 4 osteotomy and vertebral column resection (VCR) in congenital kyphosis (CK) patients with anterior failure of segmentation (type II) and to analyze the peri- and post-operative complications after SRS-Schwab Grade 4 osteotomy and VCR in this cohort.



## Methods.

Type II CK patients undergoing vertebral column resection (VCR) in our center from February 2015 to December 2018 were included in Group 1, and those undergoing SRS-Schwab Grade 4 osteotomy during the same period were enrolled in Group 2. The radiographic parameters, clinical outcomes, and quality-of-life measures at pre-operation, post-operation and follow-up were compared between groups.

The inclusion criteria were:

- (1) patients with type II CK;
- (2) with coronal Cobb angle less than  $20^{\circ}$ ;
- (3) undergoing SRS-Schwab Grade 4 osteotomy or VCR procedure;
- (4) with at least 2 years follow-up.

Patients with prior history of spinal surgery were excluded.



**Table 1 Comparison of demographic data between Group 1 and Group 2**

	Group 1 (n=19)	Group 2 (n=12)	P value
Mean Age (yr)	16.5±8.1	15.9±9.0	0.775
Gender (female/male)	13/6	8/4	0.919
Thoracic	0	0	-
Thoracolumbar	17	9	-
Lumbar	2	3	-
Unsegmented levels (No.)	3.9±0.8	2.5±0.5	<0.001*
Fusion level (No.)	8.4±2.2	5.8±2.1	0.003*
Anterior strut grafts	6	0	<0.001*
Follow-up (month)	49.5±17.9	46.4±19.2	0.651
Operation time (min)	275.9±81.2	213.4±78.9	0.044*
Estimated Blood loss (ml)	975.2±215.8	725.9±189.3	0.003*
Complications			
Intra-operative dual tear	2	1	1.000
Neurological deficit	1	0	-
Neuromonitoring changes	0	1	-
PJK	2	1	1.000



**Table 2 Comparison of radiographic measurements between Group 1 and Group 2 (Part 1)**

	Group 1 (n=19)	Group 2 (n=12)	P value
Pre-operative			
Coronal Cobb angle (°)	11.1±5.5	10.4±8.4	0.780
SK (°)	68.3±17.9	57.1±21.2	0.125
PI (°)	27.8±12.3	29.1±14.3	0.790
PT (°)	6.7±10.4	7.9±13.3	0.781
SS (°)	20.7±13.8	20.4±11.6	0.951
TLK (°)	56.3±42.4	37.1±31	0.186
TK (°)	21.3±38.5	20.1±26.5	0.925
LL (°)	23.3±53.4	16.1±30.8	0.675
PI(°)	41.7±9.3	40.9±10.7	0.827
PT(°)	12.4±6.8	11.9±7.0	0.845
SS(°)	29.3±7.0	29.0±7.2	0.909
SVA (mm)	-24.7±31.5	-6.1±28.7	0.109



**Table 2 Comparison of radiographic measurements between Group 1 and Group 2 (Part 2)**

	Group 1 (n=19)	Group 2 (n=12)	P value
Post-operative			
Coronal Cobb angle (°)	3.3±1.9	4.5±4.0	0.268
SK (°)	17.2±20.0*	11.7±11.2*	0.393
PI (°)	28.3±11.3	30.3±12.6	0.649
PT (°)	2.3±10.2	8.4±13.3	0.160
SS (°)	26.1±14.3	24.3±11.6	0.717
TLK (°)	16.8±15.4	9.9±9.0	0.171
TK (°)	19.4±16.4	19.4±10.6	1.000
LL (°)	38.0±23.9	28.8±13.1	0.233
PI(°)	41.1±9.8	40.2±10.8	0.926
PT(°)	10.2±7.0	9.4±7.4	0.788
SS(°)	31.9±7.3	30.8±7.6	0.881
SVA (mm)	-6.2±23.9	6.6±13.8	0.082



**Table 2 Comparison of radiographic measurements between Group 1 and Group 2 (Part 3)**

	Group 1 (n=19)	Group 2 (n=12)	P value
The latest follow-up			
Coronal Cobb angle (°)	4.7±1.7	4.9±5.6	0.884
SK (°)	20.3±18.0*	12.8±15.4*	0.243
PI (°)	31.7±11.4	30.9±17.3	0.877
PT (°)	6.8±12.9	9.6±11.2	0.541
SS (°)	24.5±10.2	22.3±14.6	0.625
TLK (°)	12.5±20.7	11.7±14.0	0.907
TK (°)	22.8±20.8	32.4±11.2	0.154
LL (°)	34.0±21.4	28.8±15.4	0.472
PI(°)	42.4±10.6	41.2±11.2	0.766
PT(°)	11.0±7.1	10.2±7.6	0.768
SS(°)	31.4±7.3	31.0±7.6	0.885
SVA (mm)	-19.3±21.6	-7.3±28.7	0.195



**Table 2 Comparison of radiographic measurements between Group 1 and Group 2 (Part 4)**

	Group 1 (n=19)	Group 2 (n=12)	P value
<b>Correction of SK</b>			
Pre-operation minus post-operation	51.1±17.6	45.4±19.8	0.409
The latest follow-up minus pre-operation	48.0±17.1	44.3±20.1	0.588

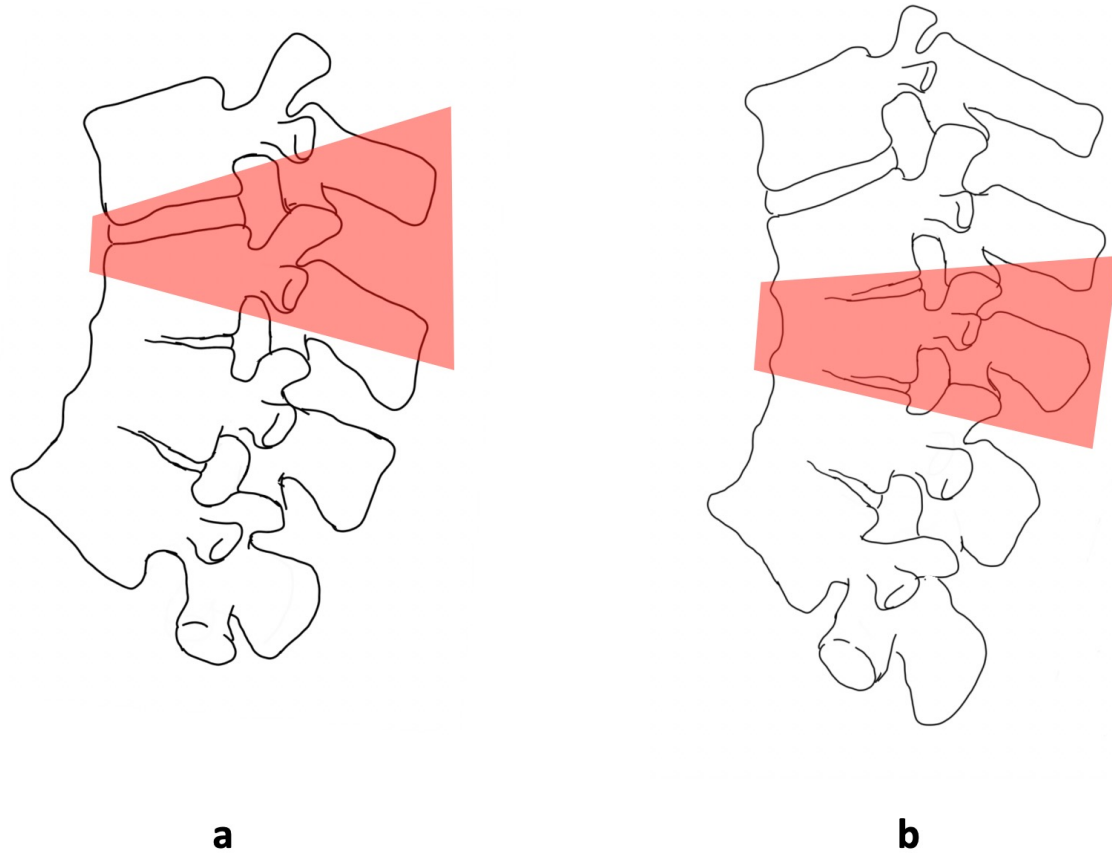




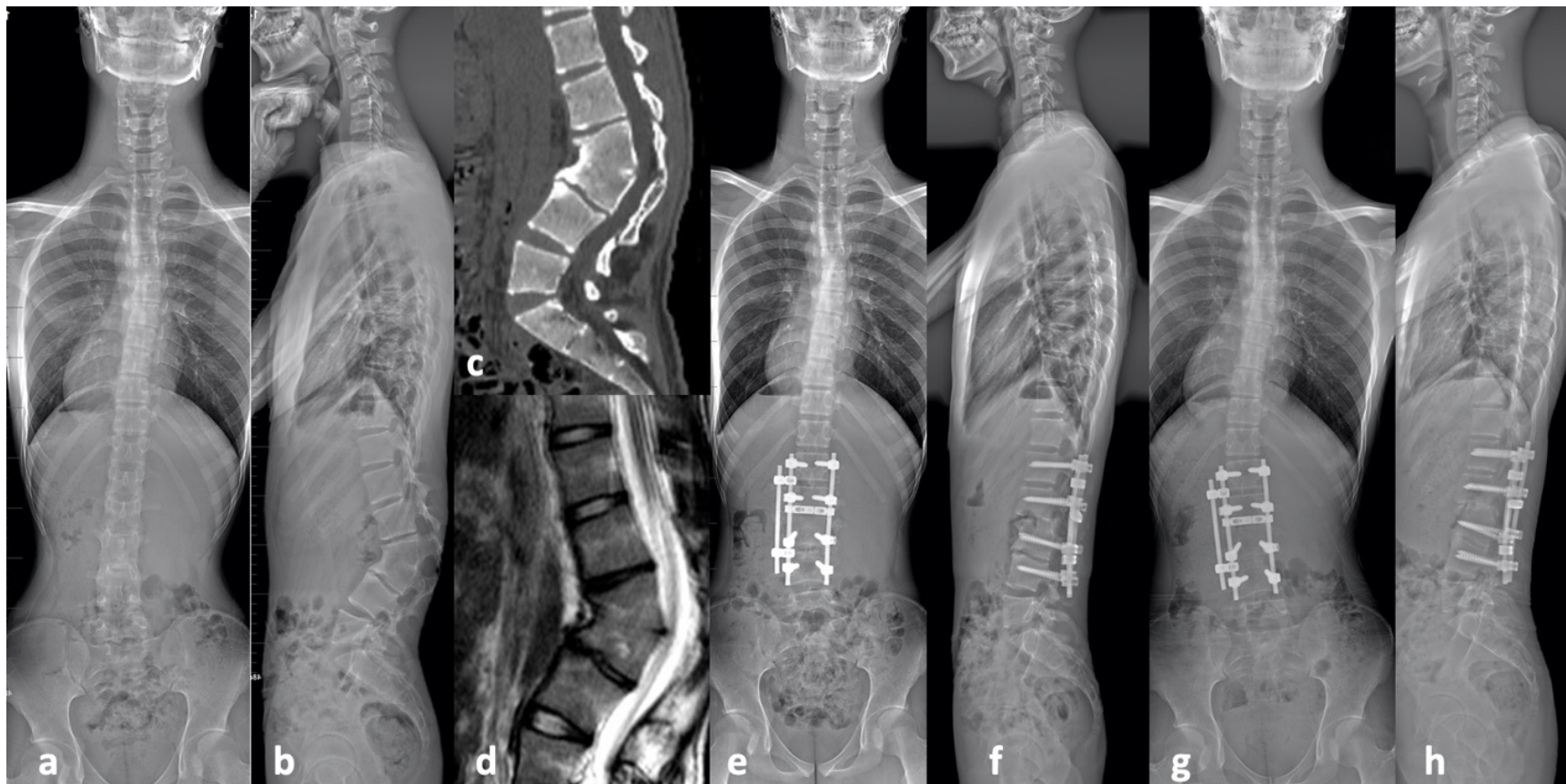
**Table 3:** Comparison of health-related quality-of-life parameters among pre-operation, 3-month follow-up and the latest follow-up.

	SRS-22				
	Pain	Self-Image	Function	Satisfaction	Mental Health
<b>Group 1</b>					
<b>Pre-operation</b>	3.4±1.3	3.0±0.8	3.4±0.5	2.8±1.3	3.9±0.5
<b>3-month follow-up</b>	3.9±0.7	3.9±1.0	3.6±0.8 <sup>a</sup>	3.8±1.0	4.0±0.6
<b>P (pre-operation vs. 3-month follow-up)</b>	0.047*	0.004*	0.898	0.012*	0.580
<b>The latest follow-up</b>	4.0±0.8	3.9±1.0	4.0±0.5	3.7±1.0	3.9±0.7
<b>P (pre-operation vs. the latest follow-up)</b>	0.028*	0.004*	<0.001*	0.022*	1.000
<b>Group 2</b>					
<b>Pre-operation</b>	3.9±0.7	3.2±0.8	3.6±0.4	3.0±1.2	4.1±0.4
<b>3-month follow-up</b>	4.0±0.8	4.1±0.7	4.1±0.4 <sup>a</sup>	4.0±0.9	4.2±0.4
<b>P (pre-operation vs. 3-month follow-up)</b>	0.746	0.007*	0.022*	0.030*	0.547
<b>The latest follow-up</b>	4.1±0.6	4.0±0.7	4.1±0.4	4.0±1.1	4.1±0.5
<b>P (pre-operation vs. the latest follow-up)</b>	0.460	0.016*	0.006*	0.045*	1.000

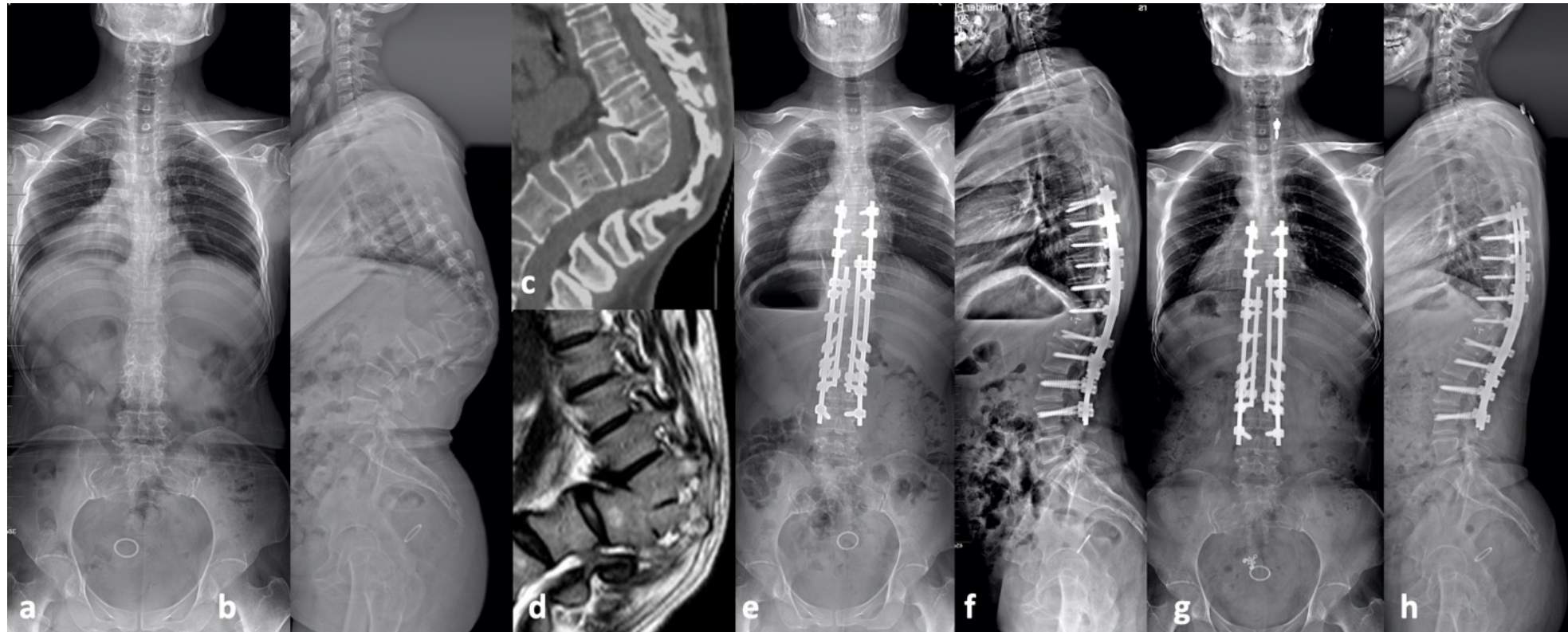




**Figure 1.** Indication for SRS-Schwab Grade 4 osteotomy in type II congenital kyphosis: the apex of kyphosis should be the upper vertebra of failed segmentation bar or the disc above (**a**). Indications for vertebral column resection in type II congenital kyphosis: the apex of kyphosis was located within the unsegmented region and with neighboring upper and inferior residual discs (**b**).



**Figure 2.** A 16 years old boy with L2-L3 failures of anterior segmentation (**a-d**). The patient underwent SRS-Schwab Grade 4 osteotomy at L1/2 level followed with posterior instrumented fusion (**e, f**). At 3 years follow-up, the patient achieved solid bone fusion and the correction was well maintained (**g, h**).



**Figure 3.** A 51 years old female with T11-L1 failures of anterior segmentation (**a-d**). The patient underwent VCR at T12 level and followed with posterior satellite rods instrumented fusion (**e, f**). At 2 years follow-up, the patient achieved solid bone fusion and the correction was well maintained (**g, h**).

## Conclusions

Both SRS-Schwab Grade 4 osteotomy and VCR could be well applied in type II CK patients. Patients undergoing VCR suffered from longer operation time, more blood loss and higher inherent risks of peri- and post-operative complications.

