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Higher Flexibility and Better Immediate Spontaneous Correction May Not Gain Better Results for Nonstructural Thoracic Curve in Lenke 5C AIS Patients

Risk Factors for Its Correction Loss

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Study Design. Retrospective study.

Objective. To study the behavior of the unfused thoracic curve in Lenke type 5C during the follow-up and to identify risk factors for its correction loss.

Summary of Background Data. Few studies have focused on the spontaneous behaviors of the unfused thoracic curve after selective thoracolumbar or lumbar fusion during the follow-up and the risk factors for spontaneous correction loss.

Methods. We retrospectively reviewed 45 patients (41 females and 4 males) with AIS who underwent selective TL/L fusion from 2006 to 2012 in a single institution. The follow-up averaged 36 months (range, 24–105 months). Patients were divided into two groups. Thoracic curves in group A improved or maintained their curve magnitude after spontaneous correction, with a negative or no correcion loss during the follow-up. Thoracic curves in group B deteriorated after spontaneous correction with a positive correction loss. Univariate analysis and multivariate analysis were built to identify the risk factors for correction loss of the unfused thoracic curves.

Results. The minor thoracic curve was 26° preoperatively. It was corrected to 13° immediately with a spontaneous correction of 48.5%. At final follow-up it was 14° with a correction loss of 1°. Thoracic curves did not deteriorate after spontaneous correction in 23 cases in group A, while 22 cases were identified with thoracic curve progressing in group B. In multivariate analysis, two risk factors were independently associated with thoracic correction loss: higher flexibility and better immediate spontaneous correction rate of thoracic curve.

Conclusion. Posterior selective TL/L fusion with pedicle screw constructs is an effective treatment for Lenke 5C AIS patients. Nonstructural thoracic curves with higher flexibility or better immediate correction are more likely to progress during the follow-up and close attentions must be paid to these patients in case of decompensation.

Key words: adolescent idiopathic scoliosis, correction loss, posterior selective fusion, risk factors, unfused thoracic curve.

Level of Evidence: 4

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Achieving global spinal balance, preventing curve progression, and sparing mobile segments are major goals of corrective surgery in adolescent idiopathic scoliosis (AIS). Spine surgeons attempted to preserve maximal mobility of the spine, as well as a minimal number of the fused segments. Selective fusion has been widely accepted by spine surgeons.[1–4] Posterior selective thoracolubmar or lumbar (TL/L) fusion is considered a major treatment to Lenke 5C AIS patients with structural TL/L curve and nonstructural or compensatory thoracic curve. Attention has been paid to the prognosis of the unfused thoracic segments. However, few studies have focused on the chronical spontaneous behaviors of the unfused thoracic curve after selective fusion during the follow-up and the risk factors for correction loss. The purpose of this study was to study the behavior of the unfused thoracic curve during the follow-up and to identify risk factors for its correction loss.

MATERIALS AND METHODS

After the approval of the institutional review board of the hospital, patients of Lenke 5C AIS were identified in a single institution for the time periods from January 2006 to December 2012. Criteria for Lenke 5C classification[2] were used, and confirmed with independent physician examiners familiar with this classification. The main thoracic and upper thoracic curves are nonstructural, which means that their magnitude is less than the primary structural curve, they bend out to be less than 25° on convex side-bending radiographs, and no sagittal kyphosis criteria are met (T10-L2 and T2-T5 are less than 20°). Exclusion criteria were: age >20, non-idiopathic curve, follow-up <2 years, incomplete follow-up materials, and poor radiographic images to measure.

According to thoracic correction loss, we divided all patients into two groups. The thoracic curves in group A improved or maintained their magnitude during the follow-up, with a negative or no correction loss. Thoracic curves in group B deteriorated with a positive correction loss. Two of the authors (YZ, SW) conducted all radiographic measurements. Radiographic analysis included various parameters on the preoperative, immediate postoperative (within 2 weeks), and final follow-up radiographs. We presumed the Cobb angle to be reliably measured to be within 5°. We measured global coronal balance as the horizontal distance between the C7 plumb line (C7PL) and the central sacral vertical line (CSVL). The Apical Vertebral Translation (AVT) was measured as the distance between the center of the apical vertebra and C7PL in thoracic curve or CSVL in TL/L curve. The horizontal plane was defined as the plane perpendicular to the long axis of the radiograph. Lower instrumented vertebra (LIV) tilt measured the inclination in degrees of the inferior endplate of the LIV to the horizontal plane. The coronal lower instrumented vertebra disc angle (LIVA) immediately below the LIV was measured as the angulation in degrees of the inferior endplate of the lower instrumented vertebra (LIV) relative to the superior endplate of the next caudal vertebra. The coronal upper instrumented vertebra disc angle (UIVA) immediately above the upper instrumented vertebra (UIV) was measured as the angulation in degrees of the upper endplate of the UIV relative to the lower endplate of upper adjacent vertebra. On the lateral radiographs, we measured global sagittal balance as the distance from the C7PL to the perpendicular line drawn from the superior posterior endplate of S1 vertebral body (SSVL). Thoracic kyphosis was measured from T5 to T12 and lumbar lordosis was from L1 to S1. Thoracolumbar junction was measured from T10 to L2. UIVA and LIVA were also measured in the sagittal plane.

Surgical technique: The patient was placed prone on a radiolucent spinal frame after administering incubated general anesthesia. After surgical exposure, pedicle screws were placed with free hand technique. Once the screws were in place, intraosseous placement was confirmed via C-arm image intensifier. Posterior release were performed where was needed. The convex rod was placed first in all patients. Curve correction was achieved with direct apical vertebral body rotation, rod rotation, and compression and/or distraction. Decortication of the posterior elements was performed and followed by bone graft finally. Sensory- and motor-evoked potentials were used intraoperatively.

We calculated overall summary statistics in terms of means and SDs for continuous variables and frequencies for categorical. After the descriptive analysis, P value was calculated using independent sample t tests for continuous variables obeying normal distribution. For those not obeying normal distribution, nonparametric tests were used. We evaluated group differences for categorial variables using χ^2 or Fisher exact test. A multivariable binary logistic regression model, with backward stepwise elimination (Conditional), was created to evaluate the adjusted associations of each potential explanatory variable predicting the behaviors of the unfused thoracic curves. We considered variables with a univariate significance level of 0.05, or variables that we thought were clinically relevant to be eligible for inclusion in the multivariate analysis. For all regression models, the adjusted odds ratio and their subsequent 95% CIs were reported. We performed all analyses using SPSS version 17.0.

RESULTS

We identified 45 AIS patients of Lenke 5C treated with primary posterior selective TL/L fusion with pedicle screw constructs. There were 41 female and 4 male patients with an average age of 15 years (range, 12–20 yr) (Table 1). The follow-up averaged 36 months (range, 24–105 months). The coronal Cobb angle of the TL/L curve averaged 44° (range 30°–72°) preoperatively and it was corrected to 6° (range 0°–22°) postoperatively with an immediate correction rate of 84.8%. At final follow-up it was 9° (range 0°–28°) with a correction loss of 3° (range −10° to 14°). The minor thoracic curve was 26° (range 10°–43°) preoperatively, and the convex side bending Cobb angle averaged 8° (range 0°–18°) with a flexibility of 72.7% (range 34–153%). It was corrected to 13° (range 1°–30°) immediate postoperatively with a spontaneous correction of 48.5% (range 4.3%–95.4%). At final follow-up it was 14° (range 0°–32°) with a correction loss of 1° (range −17° to 13°). A typical case has been shown in Figure 1A–H. General coronal and sagittal measurements can be seen in Tables 2 and 3, respectively.

Thoracic curves did not deteriorate after spontaneous correction in 23 cases in group A, while 22 cases were identified with thoracic curve progressing in group B. The correction losses were −4° (range −17° to 0°) and 5° (range 1°–13°), respectively. Comparison of parameters between two groups is shown in Table 4. General conditions and preoperative curve magnitudes, especially thoracic curve magnitude and thoracic convex side-bending curve magnitude, showed no significant difference between two groups. Before surgery thoracic flexibility in group B (79.4%) was

TABLE 1. Patients Characteristics

No.	Sex	Age	Follow-Up	Lenke	Risser
1	F	14	105	5C	III
2	F	20	100	5C	V
3	F	13	32	5C	III
4	F	12	78	5C	III
5	M	13	48	5C	III
6	F	13	45	5C	III
7	F	19	64	5C	V
8	F	15	30	5C	IV
9	F	14	72	5C	III
10	F	14	72	5C	III
11	F	16	24	5C	IV
12	F	15	60	5C	V
13	F	17	24	5C	V
14	F	13	29	5C	III
15	M	12	26	5C	III
16	F	13	38	5C	III
17	F	16	38	5C	V
18	F	19	28	5C	V
19	F	13	24	5C	III
20	F	14	24	5C	IV
21	F	15	24	5C	IV
22	F	14	30	5C	V
23	F	14	50	5C	IV
24	F	16	24	5C	V
25	F	16	43	5C	V
26	F	14	24	5C	III
27	F	19	24	5C	V
28	F	13	32	5C	III
29	F	15	36	5C	IV
30	F	15	24	5C	IV
31	F	19	24	5C	V
32	F	17	24	5C	V
33	F	12	24	5C	III
34	M	16	24	5C	V
35	F	12	26	5C	III
36	F	14	26	5C	IV
37	F	19	24	5C	V
38	M	16	24	5C	V
39	F	16	24	5C	V
40	F	15	24	5C	V
41	F	14	24	5C	IV
42	F	13	24	5C	IV
43	F	13	24	5C	IV
44	F	15	24	5C	V
45	F	15	24	5C	V

significantly higher than that in group A (65.6%). After correction and selective TL/L fusion, compared with group A, thoracic curve in group B had smaller curve magnitude (11° *vs.* 16°, $P = 0.021$), better immediate spontaneous correction rate (58.2% *vs.* 38.3%, $P = 0.006$). However, at final follow-up, thoracic curve in group B had larger curve magnitude (16° *vs.* 12°, $P = 0.043$) and lower final spontaneous correction rate (36.2% *vs.* 53.6%, $P = 0.028$).

Our data suggested that in univariate analysis there are several potential risk factors associated with thoracic correction loss, including higher flexibility, smaller postoperative curve magnitude and better immediate spontaneous

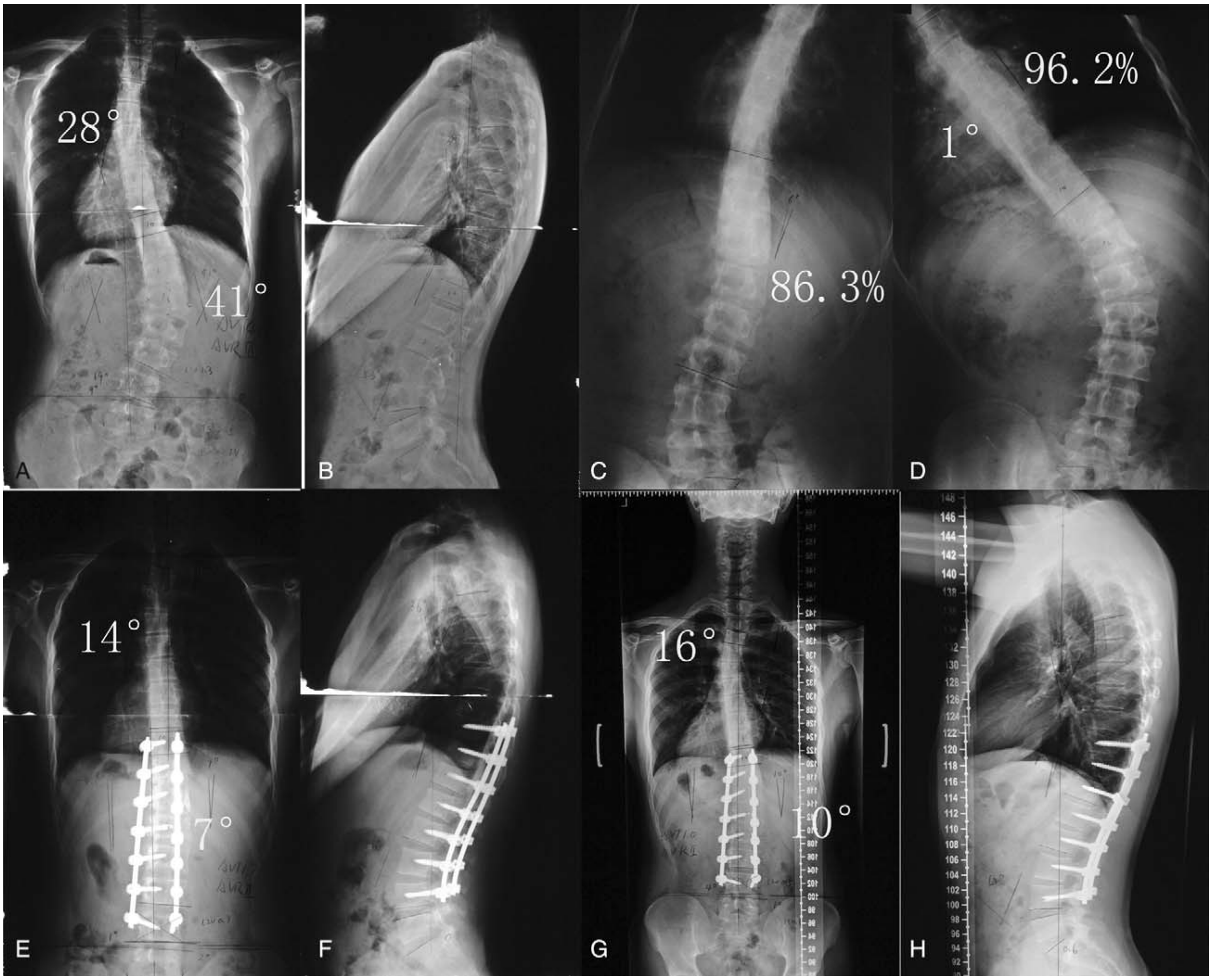

Figure 1. (**A–H**) A 14-year-old female patient. Flexibility of the thoracic and TL/L curve was calculated as 96.2% and 86.3%, respectively (**C, D**). After selective fusion, the thoracic curve spontaneously corrected from 28° to 14° (**A, E**). At final follow-up, it was 16°, with a correction loss of 2°. Coronal and sagittal balances were well maintained both in the immediate postoperation and final follow-up.

correction rate of thoracic curve, and better immediate TL/L correction rate. However, in multivariate analysis, we found only two risk factors were independently associated with thoracic correction loss: higher flexibility (odds ratio = 1.051; 95% CI: 1.007–1.097; $P = 0.023$) and better immediate spontaneous correction rate of thoracic curve (odds ratio = 1.041; 95% CI: 1.009–1.074; $P = 0.012$) (Table 5).

TABLE 2. Comparison of Preoperative, Postoperative, and Final Follow-Up Coronal Measurements

Parameter	Pre-Op	Post-Op	Follow-Up	*P*
TL/L (°)	44 ± 7	6 ± 5	9 ± 5	<0.01*
Thoracic (°)	26 ± 7	13 ± 7	14 ± 8	<0.01*
GCB (mm)	21.3 ± 11.5	19.5 ± 13.3	10.9 ± 8.9	<0.01*
AVT (TL/L) (mm)	42.5 ± 12	12.9 ± 8.4	11.1 ± 8.8	<0.01*
AVT (T) (mm)	12.6 ± 6.8	15.2 ± 8.6	12.1 ± 9.1	0.681
LIV tilt (°)	22 ± 5	4 ± 4	4 ± 3	<0.01*
UIVA (°)	4 ± 3	2 ± 2	2 ± 2	<0.01*
LIVA (°)	7 ± 5	4 ± 3	5 ± 4	0.05

*Means significant difference of the parameters between pre-op and final follow-up.

AVT indicates apical vertebral translation; GCB, global coronal balance; LIV, lower instrumented vertebra; LIVA, coronal lower instrumented vertebra; TL/L, thoracolumbar or lumbar; UIVA, coronal upper instrumented vertebra.

TABLE 3. Comparison of Preoperative, Postoperative, and Final Follow-Up Sagittal Measurements

Parameter	Pre-Op	Post-Op	Follow-Up	*P*
T5-T12 sagittal (°)	18 ± 9	24 ± 8	28 ± 12	<0.01*
T10-L2 sagittal (°)	8 ± 8	5 ± 4	7 ± 5	0.345
L1-S1 sagittal (°)	53 ± 12	56 ± 10	59 ± 10	0.038*
UIVA sagittal (°)	2 ± 3	1 ± 2	2 ± 3	0.319
LIVA sagittal (°)	13 ± 7	13 ± 6	14 ± 7	0.221
GSB (mm)	31.0 ± 23.5	35.8 ± 24.3	21.8 ± 16.8	0.017*

*Means significant difference of the parameters between pre-op and final follow-up.
GSB indicates global sag1ttal balance; LIVA, sagittal lower instrumented vertebra; UIVA, sagittal upper instrumented vertebra.*

Of all the 45 patients, only one patient in group B received revision surgery to fuse the progressive thoracic curve. There was no neurologic complication or sign of pseudarthrosis on final follow-up radiographs.

DISCUSSION

Surgical correction of AIS aims to obtain a well-balanced spine, maximal functionality of the spine, and maximal correction of the curvature. Selective fusion has gained popularity over decades.[2,3,5–7] Although both anterior and posterior selective TL/L fusion turned out to be effective treatments for AIS with structural TL/L curve and compensatory thoracic curve,[3,8–15] studies have figured out that the anterior method may result in a higher incidence of kyphosis, pseudarthrosis, and loss of correction.[16] Posterior selective TL/L fusion has many advantages like better curve correction, less loss of correction overtime, less loss of blood, and shorter hospital stays over anterior approach,[12] and it has been widely accepted by spine surgeons in recent years. In several studies attention has been paid to the prognosis of the unfused thoracic segment after selective TL/L fusion.

Ilgenfritz *et al*[5] reported the uninstrumented compensatory thoracic curves were corrected by a mean of 37% at first erect, 37% at 2 years, and 30% at 5 years after selective TL/L fusion. Lark *et al*[17] reported the unfused thoracic curve spontaneous corrected from 34° to 22° at final follow-up in either anterior or posterior approach. In the present study, posterior selective TL/L fusion achieved 84.9% curve correction for the TL/L curve and 48.5% spontaneous correction for the minor thoracic curve immediate postoperatively. There was a correction loss of 3° and 1° respectively after 2 years of follow-up. And the final correction rate was 78.9% and 44.7%, respectively, which consisted of previous studies. Coronal balance and sagittal contours were well maintained at final follow-up. No major complications occurred at final follow-up. It turned out to be quite effective for the surgical correction of Lenke 5C AIS.

Previous literatures had studied the prognosis of the unfused thoracic curve after anterior selective TL/L fusion. Huitema *et al*[1] observed a significant correlation in the correction rate of the TL/L and thoracic curves, and they concluded that the spontaneous thoracic curve correction is a reflection of the TL/L curve correction in Lenke 5C AIS patients. Alpaslan *et al*[4] stated that if the correction of the major curve was incomplete, the spontaneous improvement of the minor curve might also be incomplete. Therefore, overcorrection of the primary curve may result in more effective minor curve correction. Both the studies emphasized the relationship of the correction between TL/L and thoracic curves. But they did not study how the unfused thoracic curve corrected itself spontaneously on the premise that the fused TL/L curve remained relatively stable after selective TL/L fusion during the period of follow-up.

In recent years, with the wide application of pedicle screw constructs, prognosis of the unfused thoracic curve after posterior correction and fusion was studied too. Li *et al*[18] found 32 unfused thoracic curve improvement out of 42 patients at final follow-up after posterior selective TL/L fusion and instrumentation. They found that preoperative thoracic curvature and thoracic curvature on lateral bending were strongly correlated with the final thoracic curvature. However, in the present study, preoperative thoracic curvature shows no significant difference between groups A and B, and the final thoracic curvature is significantly larger in group A, which means larger final thoracic curvature may not result from larger preoperative thoracic curvature. Thoracic curves in group B are more flexible, but it turned out to be larger compared with that in group A at final follow-up. Methods of grouping in the present study are different from Li, so our conclusions did not completely conflict with each other.

Wang *et al*[19] found no significant correlation of the correction rate between two curves after posterior selective fusion, but they found a significant correlation between the decrease in the thoracic curve and the decrease in the TL/L curve at the immediate postoperative measurements and a significant correlation between the changes in the Cobb angles in the thoracic and TL/L curves at final follow-up. So they also concluded that spontaneous correction of the thoracic curve is a reflection of the TL/L curve correction after posterior selective TL/L fusion like Huitema. They also found that supine side bending radiographs are effective methods of predicting the spontaneous correction of thoracic curves and higher flexibility was associated with spontaneous correction. In the present study, we found similar results that thoracic curve with higher flexibility in group A had better immediate spontaneous correction. Most

TABLE 4. Univariate Analysis of Risk Factors for Correction Loss of Thoracic Curve

Parameter		A	B	*P*
Sex		F:19 M:3	F:22 M:1	0.568
Age		15 ± 2	15 ± 2	0.73
Follow-up (M)		38 ± 22	35 ± 20	0.94
TL/L Cobb (°)	Pre-op	45 ± 10	42 ± 11	0.34
	Post-op	6 ± 5	7 ± 4	0.075
	PO-CR	88 ± 10	82 ± 12%	0.042
	Follow-up	9 ± 6	9 ± 5	0.764
	FU-CR	79 ± 13%	79 ± 12%	0.66
	LOST	4 ± 4	2 ± 5	0.093
Thoracic Cobb (°)	Pre-op	26 ± 8	26 ± 8	0.825
	Post-op	16 ± 7	11 ± 6	0.021
	PO-CR	38 ± 25%	58 ± 21%	0.006
	Follow-up	12 ± 7	16 ± 8	0.043
	FU-CR	54 ± 25	36 ± 27%	0.028
Thoracic convex bending (°)		9 ± 6	7 ± 6	0.172
Flexibility	Lumbar	75 ± 23	84 ± 20%	0.166
	Thorac1c	66 ± 20	79 ± 24%	0.044
Fused segments		6 ± 1	6 ± 1	0.23
Coronal global balance (mm)	Pre-op	22.4 ± 9.0	20.2 ± 13.7	0.531
	Post-op	19.1 ± 13.3	19.9 ± 13.6	0.865
	Follow-up	11.3 ± 11.7	8.3 ± 8.8	
AVT (TL/L) (mm)	Pre-op	44.4 ± 12.3	40.7 ± 11.7	0.309
	Post-op	12.1 ± 9.4	13.8 ± 7.4	0.499
	Follow-up	14.7 ± 9.7	7.7 ± 6.4	
AVT (T) (mm)	Pre-op	13.4 ± 6.9	11.8 ± 6.9	0.43
	Post-op	15.6 ± 8.9	13.9 ± 8.4	0.316
	Follow-up	11.9 ± 10.0	12.3 ± 8.5	
UIVA (°)	Pre-op	4 ± 3	3 ± 3	0.491
	Post-op	2 ± 2	2 ± 2	0.935
	Follow-up	2 ± 2	2 ± 2	
LIVA (°)	Pre-op	7 ± 5	6 ± 5	0.954
	Post-op	4 ± 2	3 ± 3	0.1
	Follow-up	4 ± 4	4 ± 6	
LIV TILT (°)	Pre-op	23 ± 6	22 ± 5	0.816
	Post-op	4 ± 4	4 ± 4	0.967
	Follow-up	5 ± 3	3 ± 3	
Sgt (T5-T12) (°)	Pre-op	18 ± 8	19 ± 10	0.78
	Post-op	22 ± 6	25 ± 9	0.263
	Follow-up	25 ± 12	31 ± 12	
Sgt (T10-L2) (°)	Pre-op	10 ± 10	6 ± 5	0.12
	Post-op	6 ± 4	5 ± 3	0.291
	Follow-up	7 ± 4	7 ± 5	
Sgt (L1-S1) (°)	Pre-op	51 ± 13	55 ± 12	0.284
	Post-op	56 ± 11	57 ± 10	0.75
	Follow-up	58 ± 10	60 ± 10	

AVT indicates apical vertebral translation; FU-CR, correction rate of final follow-up; LIVA, lower instrumented vertebral disc angle; PO-CR, correction rate of immediate postoperation; sgt, sagittal cobb angle; UIVA, upper instrumented vertebra disc angle.

previous researches have considered the spontaneous correction as an entire process. However, the unfused thoracic curvature had gone through two processes: the immediate spontaneous correction after surgery and chronic spontaneous correction during the period of follow-up when the fused TL/L curve was relatively stable. And few researches have studied the chronic process, progressed or improved. Why the unfused thoracic curve progressed or improved during the follow-up compared with immediate postoperation is still unclear so far. Few studies had

TABLE 5. Multivariate Analysis of Risk Factors for Correction Loss of Thoracic Curve

Parameter	Odds Ratio (95% CI)	*P*
ILCR	0.01 (0.00, 10.86)	0.247
ITCM	1.00 (0.81, 1.25)	0.963
ITSCR	55.67 (2.38, 1302.66)	0.012
Thoracic flexibility	147.37 (2.00, 10838.22)	0.023
Sex	10.16 (0.71, 146.18)	0.08
Age	1.027 (0.94, 1.12)	0.558

ILCR indicates immediate TL/L curve correction rate; ITCM, immediate thoracic curve magnitude; ITSCR, immediate thoracic spontaneous correction rate.

explained why correction loss of the thoracic curve occurred.

Based on above, we performed subgroup analysis according to the thoracic curve behavior during the follow-up. Improvement or maintenance of the thoracic curve was observed in group A and progression in group B. Preoperative patient characteristics and radiographic parameters showed no significant difference between two groups (Table 4). Univariate analysis revealed that thoracic curvature in group B had a higher preoperative flexibility, smaller curve magnitude, higher spontaneous correction rate, and lower TL/L curve correction rate at immediate postoperation. But they had larger curve magnitude, lower final spontaneous correction rate at final follow-up. And all other characteristics and radiographic parameters showed no significant difference. So in group B the unfused thoracic curve, with higher flexibility, seemed to have a better spontaneous correction at immediate postoperation, but the correction was not well maintained at final follow-up. On the other hand, the thoracic curve in group A, with lower flexibility, had a relatively unsatisfactory spontaneous correction at first erect, but the spontaneous correction improved at final follow-up.

To explore if the parameters such as higher thoracic curve flexibility, lower immediate TL/L curve correction rate, smaller immediate thoracic curve magnitude, higher immediate thoracic spontaneous correction rate were potential risk factors for positive correction loss of the unfused thoracic curve during follow-up, multivariate binary logistic regression was performed. It revealed that higher thoracic curve flexibility and immediate thoracic spontaneous correction rate are the independent risk factors for the positive correction loss of the unfused thoracic curve during the follow-up.

There is one possible explanation for this phenomenon: higher flexibility and spontaneous correction rate may cause a larger margin of magnitude change. This could obviously increase the tension of the concave side tissues, which contained more fibrosis and fatty involution,[20] and

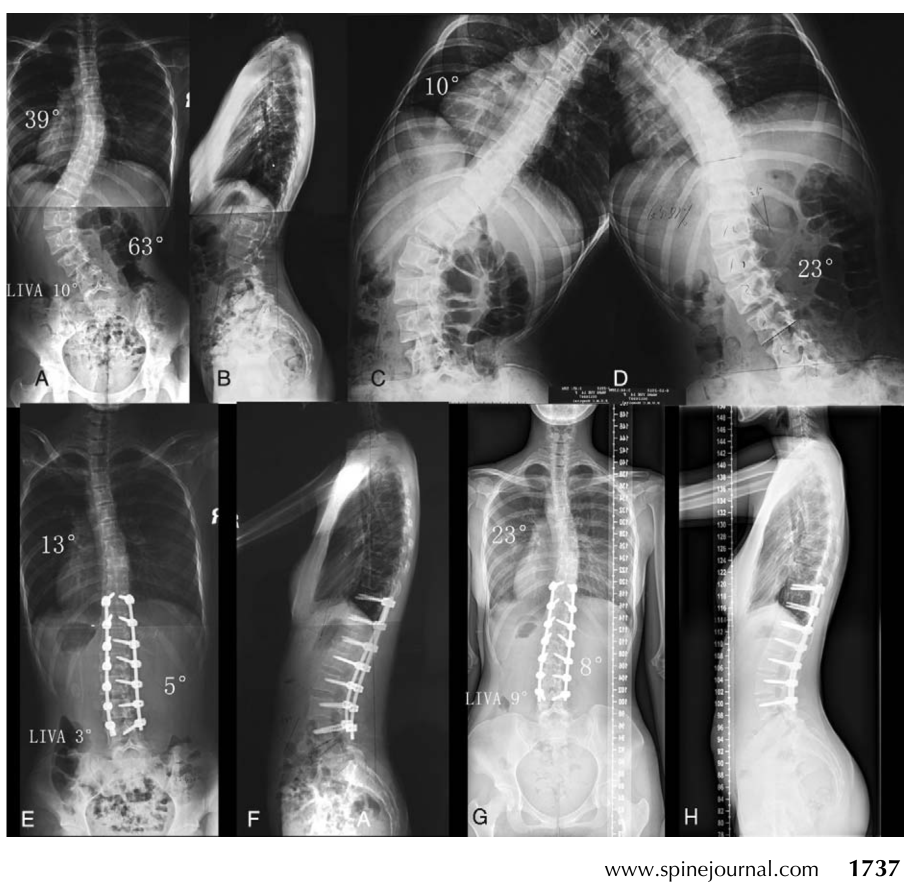

Figure 2. (**A–H**) A 15-year-old female patient. Flexibility of the thoracic and TL/L curve was calculated as 74.4% and 58.7%, respectively (**C, D**). After selective fusion, the thoracic curve spontaneously corrected from 39° to 13°. LIVA decreased from 10° to 3° (**A, E**). At final follow-up, thoracic curve was 23°, with a correction loss of 10°. LIVA increased from 3° to 9° in reverse (**G**). LIVA and thoracic curve both progressed during follow-up. LIVA indicates lower instrumented vertebra disc angle.

exacerbate the tendency to progress during the follow-up. And flexible curves are susceptible to this tendency to progress. Lower flexibility and spontaneous correction rate of the unfused thoracic curve may cause a relatively smaller change of the curve magnitude. This may not increase the tension of tissues on the concave side in a large margin and the tendency to progress of the thoracic curve is not so strong. But the boundary of the flexibility and correction rate between these two conditions still needs further explorations. Another possible explanation was that more flexible spine had more flexible discs. The thoracic curve progressed because of wedging of the disc below LIV like the case shown in Figure 2A–H. Also studies with more patients and longer follow-up will be needed to confirm this phenomenon and possible explanations.

There are several potential limitations in our study. First, this was a retrospective study, which may endanger the strength of the conclusions. Second, the flexibility we calculated was based on lateral bending films. So our conclusion is not fit for flexibility calculated on traction or fulcrum films. Third, most of the curves were moderate and our conclusions may not be applied to larger curves, which yet will not gain satisfactory outcome after selective fusion.

However, our study has several major strengths. First, it contained a very homogeneous group of patients. All patients were operated on by surgeons from the same institution with the similar operative indications and surgical technique. Second, few studies have focused on risk factors of the correction loss in selective TL/L fusion.

Posterior selective TL/L fusion with pedicle screw constructs is an effective treatment for Lenke 5C patients. Higher flexibility and higher immediate spontaneous correction rate may be independent risk factors for correction loss of the unfused thoracic curve during the follow-up. Nonstructural thoracic curvatures with higher flexibility or better immediate thoracic correction are more likely to progress during the follow-up and close attention must be paid to these patients in case of decompensation.

➢ Key Points

- The unfused thoracic curve had gone through two processes: the immediate spontaneous correction after surgery and chronic spontaneous correction during the period of follow-up when the fused TL/L curve was relatively stable.
- Higher flexibility was associated with better immediate thoracic correction.
- Nonstructural thoracic curvatures with higher flexibility or better immediate thoracic correction were more likely to progress during the follow-up and close attentions must be paid to these patients in case of decompensation.

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