

Is there an Anatomic Basis for the Different Behavior of Lenke Types 1AR and 1AL in Idiopathic Scoliosis? A Study on Facet Joint Tropism Influence

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INTRODUCTION: Adolescent idiopathic scoliosis (AIS) type 1 Curves are subclassified based on the tilt of L4 as 1AR and 1AL. These curves are different with regard to their curve behavior, progression, and level selection. Presently there is no known anatomic etiology for the different behavior. Facet tropism (FT) is defined as the asymmetry between the facet angle of the left and right facet joints. The purpose of this study was to evaluate the correlation between facet tropism in the lumbar segments and occurrence of type 1AR and 1AL curves in AIS patients.

METHODS: AIS patients with diagnosis of type 1 AR and 1AL right thoracic AIS curves who underwent posterior instrumented fusion were queried from a single institutions' database. Patients needed to have an MRI of their entire spine to be included. L2-3, L3-4, and L4-5 Facet angles (FA, angle made by the facet line with the mid-sagittal line at respected vertebral level) were calculated. FT was classified as follows: $\leq 5^\circ$ (mild), $6- 10^\circ$ (moderate), and $\geq 11^\circ$ (severe). 1AR and 1AL curves were compared for FA, FT, and FT grade at each lumbar segmental levels.

RESULTS: A total of 119 patients were included (77 females, mean age- 13.85 yrs., mean BMI- 21.63, 73 1AL and 46 1AR). The mean thoracic Cobb was $52.5 \pm 9.8^\circ$, thoracic kyphosis was $28.12 \pm 12^\circ$, and lumbar lordosis was $53.48 \pm 12.6^\circ$. L3-4 FA on the right side was more coronally oriented in 1AR curves compared to 1AL curves (37° vs. 31° , $p=0.04$). On comparing FT at each level, 1AR curves had a higher FT at L3-4 (1.5° vs. -2.3° , $p=0.01$) and L4-5 levels (5.8° vs. -0.28° , $p < 0.001$) compared to 1AL patients. Similarly, 1AR patients had significantly more patients with severe FT at L3-4 (34.8% vs. 13.7%, $p=0.02$) and at L4-5 (17.3% vs. 6.8%, $p=0.01$) compared to 1AL curves.

DISCUSSION AND CONCLUSION: L3-4 joints are more coronally oriented in 1AR curves compared to 1AL curves. 1AR patients displayed higher FT at L3-4 and L4-5 compared to 1AL patients. 1AR curves also reveal a higher percentage of severe FT at L3-4 and L4-5 levels. This may influence the curve behavior and progression in these two curve types.

Table 1: Comparison of demographic and pre-operative standing radiographic parameters between 1AR and 1A curve types in our cohort

	Group 1AL (N=73)	Group 1AR (N=46)	T value	df	P value
Age (yrs)	13.5 ± 2.1	14.2 ± 2.3	-1.66	117	0.21
BMI	21.9 ± 5.6	21.2 ± 4	0.71	115	0.47
Risser	2.2 ± 1.7	3 ± 1.8	-2.1	116	0.03
MT Cobb (°)	52.7 ± 9.4	52.1 ± 10.6	0.34	117	0.73
TK (°)	25.5 ± 10.6	32 ± 13	-2.92	112	0.004
LL (°)	53 ± 12.6	54.1 ± 12.6	-0.44	113	0.66
L1 tilt (°)	21.1 ± 9.5	22.5 ± 7.5	-0.86	117	0.38
L2 tilt (°)	15 ± 9.8	20 ± 8.6	-2.84	117	0.004
L3 tilt (°)	8.5 ± 7	14 ± 7.6	-4.00	117	< 0.001
L4 tilt (°)	-4.3 ± 5.3	8 ± 5.4	-7.1	117	< 0.001

MT- main thoracic; TK- thoracic Kyphosis; LL- Lumbar lordosis; P value in bold represent significance

Table 2: Comparison of convex and concave sided facet angles and facet tropism at lumbar segments between 1AR and 1AL curves in our cohort

	Group 1AL (N=73)	Group 1AR (N=46)	T value	df	P value
FA L2-3 (R) (°)	35.3 ± 8.3	27.9 ± 9.2	0.24	117	0.81
FA L2-3 (L) (°)	50.1 ± 7.8	27.6 ± 7.9	1.6	117	0.09
FT L2-3 (°)	-1.7 ± 7.3	0.36 ± 9.3	-1.3	117	0.17
FA L3-4 (R) (°)	33.1 ± 9.7	36.7 ± 9.6	-1.9	117	0.04
FA L3-4 (L) (°)	35.4 ± 9.2	36.1 ± 9.9	-0.39	117	0.69
FT L3-4 (°)	-2.3 ± 6.9	1.57 ± 9.8	-2.52	117	0.01
FA L4-5 (R) (°)	43.1 ± 8.8	43.8 ± 9.9	-1.60	117	0.11
FA L4-5 (L) (°)	43.3 ± 9	40 ± 10.6	1.8	117	0.07
FT L4-5 (°)	-0.28 ± 5.9	5.8 ± 6.7	-5.14	117	< 0.001

FA- Facet angle; FT- Facet tropism (Facet angle R - Facet angle L); P value in bold represent significance

Table 3: Comparison of distribution of Facet tropism severity at lumbar segments between 1AR and 1AL curves in our cohort

		Grade 1, 0-5° (Minimal FT)	Grade 2, 6-10° (Mild FT)	Grade 3, 11° (Severe FT)	Pearson Chi-Square	df	P value
L2-3	1AL	38 (52.3%)	25 (34.2%)	10 (13.7%)	4.12	2	0.12
	1AR	18 (39.1%)	15 (32.6%)	13 (28.3%)			
	Total	56 (47.3%)	40 (33.6%)	23 (19.3%)			
L3-4	1AL	39 (53.4%)	24 (32.9%)	10 (13.7%)	7.37	2	0.02
	1AR	18 (39.1%)	12 (26.1%)	16 (34.8%)			
	Total	57 (47.9%)	36 (30.3%)	26 (21.8%)			
L4-5	1AL	47 (64.3%)	21 (28.7%)	5 (6.8%)	9.09	2	0.01
	1AR	17 (36.9%)	21 (45.6%)	8 (17.3%)			
	Total	64 (53.7%)	42 (35.2%)	13 (10.9%)			

P value in bold represent significance, Facet tropism severity is graded based on the absolute value of FT at each individual level