

Introduction Despite a wide experience with growing rods (GR), there are still no established criteria on how to select the lower instrumented vertebra (LIV) at index surgery. Selecting too short an LIV may benefit growth sparing and mobility, but induce adding-on during follow-up.

Material and Methods Retrospective analysis of prospectively collected data from a multicenter database. We selected ambulatory patients, suffering from early onset scoliosis (EOS) with an idiopathic curve pattern, treated at index surgery with GR (traditional-TGR or magnetic-MAGEC), and followed by a minimum 2 years after graduation (graduation: decision when reaching maturity as final fusion or observation). Demographic, and radiographic (coronal and sagittal) data were studied. The LIV was analyzed regarding its relation to the stable vertebra (SV), the substantially touched -by the central sacral vertical line- vertebra (STV), and the not substantially touched vertebra (NSTV). Failure in LIV selection was considered when distal extension was needed due to adding-on (Δ LIV-tilt $>10^\circ$, Δ LIV-discilt $>5^\circ$, Δ TSVL >10 mm). Results 125 patients were included (66% female). Mean age at index surgery was 8.1 years, with mean 7.2 years of follow-up. The mean Cobb was 74.4°. Most frequent LIV was L3. In 65 cases the STV was chosen as LIV, in 39 it was the NSTV, and in 21 the SV. Mean distal foundation anchors were 1.9 levels. During follow-up, 70 patients (56%) developed adding-on: 0% of SV, 60% of STV, 40% of NSTV. With no differences between magnetic vs TGR. However, only 23 (32.8%) of the patients with adding-on (18.4% of the whole sample) needed distal extension: 43.4% (10) of the STV, and 56.5% (13) of the NSTV. In general terms, the rate of extension if the LIV was set at the SV was 0%, at the STV 15%, and at the NSTV 33%. Risk factors for distal extension were: excessive immediate postoperative LIV-tilt (11.2°) and LIV-discilt (5.8°). The selection of the LIV depended mainly on coronal radiographs, as sagittal images had little impact on the decision, they were less reliable. In 80% of the patients who underwent distal extension (mean 1.8 levels) this was performed during the last surgery, prolonged to SV or STV. It went down to the pelvis in only 2 occasions.

Conclusions The higher the selection of the LIV above the SV at index surgery, the higher the risk for adding-on and distal extension during follow-up. Setting the LIV at the stable vertebra is safe, while stopping at the substantially touched vertebra increases the need for distal extension during follow-up by 15%. Risk factors for extension were excessive immediate postoperative (LIV and LIVdisc) tilt.

Table comparing different variables between group 1 (Adding-on with distal extension); group 2 (Adding-on without distal extension) and group 3 (No distal extension)

	Group 1	Group 2	Group 3	P1 G1 vs G2	P2 G1 vs G3
Number	23	47	102		
Gender	10 MALE 13 FEMALE	17 MALE 30 FEMALE	34 MALE 68 FEMALE		
Index Age (yrs)	8.1	8.1	8.1	0.20	0.15
Index Cobb	74.2 ^o	74.5 ^o	74.5 ^o	0.73	0.21
Index sagittal SV	4% T9 12.5%T11 37.5% T12 12.5% L1 21% L2 12.5% L3	4.5% T7 4.5% T8 4.5% T9 2% T10 7% T11 18% T12 25% L1 29.5% L2 4.5% L3	1%T6 2% T7 5.5%T8 5.5%T9 2% T10 11% T11 17.5% T12 26% L1 19% L2 10% L3		
Index coronal					
SV	0	0	20.5%		
STV	43.4%	79.4%	53.9%		
NSTV	56.5%	20.5%	25.4%	P=0.008*	P=0.0009*
Index mean LIV	L1	L3	L3		
Postop LIV-tilt	11.2 ^o	7.8 ^o	6.6 ^o	0.03*	0.002*
Postop LIVdisctilt	5.8 ^o	3.5 ^o	2.8 ^o	0.006*	0.0002*
Postop CSVLT	16.2 mm	12.6 mm	8.26 mm	0.21	0.005*

SV: stable vertebra; STV: substantially touched vertebra; NSTV: not substantially touched vertebra; LIV: lower instrumented vertebra; CSVLT: central sacral vertical line traslation