

# Posterior angular correction method with limited apical fusion combined with fusionless treatment of flexible disc levels can reduce the number of levels fused and preserve lumbar range of motion in AIS

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## INTRODUCTION:

The surgical goals for pediatric scoliosis surgery are to create a balanced, stable spine, to preserve range of motion (ROM) especially in the lumbar spine, and to avoid complications such as revision surgery (RS) or adding on phenomenon (AO). In standard pediatric posterior scoliosis surgery (PPSS), spinal fusion is usually done with fixation placed above and below the structural curve(s) with global correction of the curve either by rotation of the rod placed into the fixation or reducing the spine to a pre-contoured rod. These methods result in the fusion of disc levels outside of the structural curves that often are flexible and even non-structural, i.e., the disc angle corrects completely with side bending. We would like to present a posterior angular correction (PAC) surgical method that can perform direct angular correction at the disc level. Our hypothesis is that this method can reduce the number of levels fused and save fusion levels compared to matched historical controls, thereby saving range of motion (ROM), especially in the lumbar spine.

## METHODS:

The PAC method is based on the observation that when a rod or a construct is placed transversely into the pedicle screw tulips of the same vertebra (IntraVertebral Interpedicle (IVIP)) in adjoining vertebrae, posterolateral compression can change the adjoining disc angle (Fig 1). To capture the correction of the disc angle, IVIP constructs have tulips that line up longitudinally (Fig 1c-h). Rods inserted into these longitudinal tulips are used for fusion. The angular correction can also be captured with polyethylene terephthalate or sublaminar bands placed through the closed heads of iliac connectors placed transversely for posterolateral vertebral tethering (PLVT) at disc levels in the compensatory curve or that are non-structural. In this IRB approved prospective study, we present the results for the first 31 AIS treated using the PAC method (avg 42.3 months, min. 36 months). The number of levels fused for each patient is compared to matched historical standard posterior fusion controls (MHC) treated with standard PPSS. Radiographic measurements from xrays at 3-month and final follow up (f/u) assess for AO and from side bending (SB) xrays at pre-op and at f/u determine the T12L5 side bending (SB) ROM. SRS 22r Questionnaire was scored pre-op and at each f/u. Statistical analysis was done using the T-test (Microsoft Excel).

**RESULTS:** Of the first 31 patients, 3 were lost to follow up, leaving 28 patients in the study. Average (avg) age was 15.9 +/- 2.3 years, pre-op main curve was 56° +/- 10°, and post-op main curve was 19.9° +/- 12° for avg correction of 64% of the main structural curve. The number of levels fused (avg 5.1 +/- 1.9) was less than in the MHC (avg 11.1 +/- 1.9) and the difference was statistically significant (p < .0001). SB lumbar ROM was preserved as pre-op (32.5° +/- 11.6°) and post-op (36.8° +/- 13.4°) T12L5 SB ROM were similar (p = .25). Lowest fused vertebra (LFV) was usually the vertebra superior to the non-structural disc level as determined by SB xrays. We generally used the last substantially touched vertebra by the central sacral vertical line as the lowest instrumented vertebra which was almost always not fused but treated with PLVT (Figure 3). Upper instrumented vertebra was either the end vertebra or the vertebra rostral to the last structural disc level as determined by SB xrays. There were two complications. In one patient, bilateral pedicle screws at the lowest fused vertebra were found to be broken at 1 year follow up. At 4 year f/u, the deformity correction did not change significantly, and mild pain was present intermittently. Patient elected not to proceed with revision surgery. In the second case, adding on phenomenon (AO) was seen. The disc angle below the thoracic fusion was convex to the left in pre-op xrays and non-structural on bending xrays. Therefore, PLVT was placed on the left side. In retrospect, the intra op xrays showed that the disc angle had changed to the right side following the PAC thoracic fusion, thus PLVT on the left side likely contributed to AO; patient underwent extension of fusion. There were no other complications. Avg SRS-22r score at final f/u was 4.5/5 and pre-op was 4.0/5 and the increase was statistically significant (p < .001).

## DISCUSSION AND CONCLUSION:

The PAC method with limited apical fusion and PLVT appears to be safe and results in significantly fewer levels fused compared to MHC and preserves lumbar SB ROM in AIS with diverse Lenke classifications. Intra op xrays should be carefully assessed when applying PLVT. One of the limitations of the study was that pre-op flexion extension xrays were not done; this has been rectified in ongoing studies.

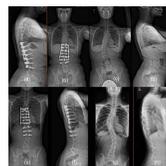
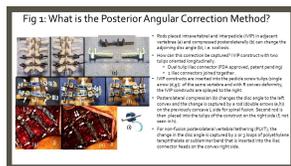


Figure 3: Other examples of Posterior Angular Correction. Pedicle screws in the pedicle screw tulips of adjacent vertebrae are used to correct the disc angle.

Parameter	Mean	Min	Max	Standard Deviation	Range
Age (years)	15.9	12.0	19.0	2.3	12-19
Pre-op Main Curve (°)	56	30	75	10	30-75
Post-op Main Curve (°)	19.9	0	35	12	0-35
Correction (%)	64	30	100	15	30-100
Number of Levels Fused	5.1	1	10	1.9	1-10
Pre-op T12L5 SB ROM (°)	32.5	10	50	11.6	10-50
Post-op T12L5 SB ROM (°)	36.8	10	50	13.4	10-50
Pre-op SRS-22r Score	4.0	3.0	5.0	0.5	3-5
Post-op SRS-22r Score	4.5	3.5	5.0	0.5	3-5
Improvement in SRS-22r	0.5	0	1.0	0.5	0-1

Note: 1 - Thoracic and upper lumbar curves summary; 2 - Post-operative correction; 3 - Main structural curve; 4 - SB ROM - side bending range of motion; 5 - Matched historical controls; 6 - ROM - side bending range of motion.