Novel Combined Limited Apical Fusion and Posterolateral Vertebral Tethering Method Can Reduce the Number of Fused Levels and Preserve Range of Motion in Lumbar Primary Adolescent Idiopathic Scoliosis

Saechin Kim¹

¹Orthopaedic Surgery, MassGeneralBrigham/Harvard Medical School INTRODUCTION:

Lumbar primary, Lenke 5 and 6, adolescent idiopathic scoliosis (AIS) curves present a challenge in preserving lumbar spine (LS) range of motion (ROM) in pediatric scoliosis surgery (PSS). The standard posterior PSS has been a spinal fusion (SF) that spans above and below the major structural curve that includes non-structural disc levels (nSDLs) that can correct significantly with side bending (SB). Though not including the nSDLs in the SF may preserve ROM, more limited SF has been associated with increased rates of adding on phenomenon (AO) and revision surgery (RS). A posterior PSS method that limits SF to the apex of the structural curve by correcting the angular deformity at each individual disc level as can be done in anterior SF for deformity and that corrects the nSDL deformity without fusion while limiting the risk for AO and RS should preserve LS ROM and be especially advantageous in lumbar primary curves. We describe a novel method using intravertebral interpedicle (IVIP) constructs made of commercially available lateral extenders and connectors placed transversely into the pedicle screw tulips of the same vertebra for limited apical SF within the major structural curve and for fusionless treatment of nSDL (Fig. 1). Our hypothesis is that the above IVIP method is safe, results in fewer levels fused, and preserves LS ROM.

In the IVIP method (Fig. 1), constructs with open lateral extenders with rods placed into the open tulips are used for SF and closed lateral extenders with polyethylene terephthalate sublaminar bands placed through the closed heads are used for fusionless posterolateral vertebral tethering (PLVT). After IRB approval of this prospective study, we compared the results using the IVIP method to that of matched historical standard posterior fusion controls (MHFC). Inclusion criteria were Lenke 5 and 6 adolescent idiopathic scoliosis (AIS) curves treated using the IVIP method with minimum 24 month f/u. Radiographic measurements from x-rays at 3-month and final f/u assess for AO and from bending x-rays at pre-op and 1- or 2-year f/u determine the ROM as the difference between the right and left side bending (SB) lumbar T12L5 Cobb angles (T12L5SBROM) and between flexion and extension (FE) L1S1 Cobb angles (FEROM). SRS 22r Questionnaire was scored pre-op and at each f/u.

RESULTS:

Seven patients met the inclusion criteria and were included in the study. For example, a Lenke 6C curve, 71° lumbar and 40° thoracic, in a 15.1 year old female (Risser 4) (Fig. 2a,b) whose last touched vertebra (LTV) by the central sacral vertical line (CSVL) is L4 (Fig. 2a) would typically be treated with a T3 to L3 (12 level) or L4 (13 level) posterior SF (Fig. 2c). For the IVIP method, we noted that the L23 disc angle changes directions with SB (Fig. 2d,e) making L23 disc a nSDL, setting the lowest fused vertebra (LFV) at L2. T6T8 and T10L2 IVIP fusion and PLVT in between and below the fusions (Fig. 2f,g) were done. T12L5SBROM is 30° preop and 31° post op showing that the SBROM is preserved. The Cobb angle of the lumbar curve is "over-corrected", i.e. reversed post-op compared to pre-op (Fig. 2f, blue lines), as one tries to do in anterior SF for scoliosis. In the study group, average (avg) age was 16.0+/-2.2 years (Risser stages 3(n=1), 4(n=3) and 5(n=3)), pre-op main curve was $57^\circ+/-8^\circ$, and post-op was $10^\circ+/-8^\circ$ for avg correction of 82%. The avg number of levels fused (4.0+/-1.3) in the IVIP group was less than that in the MHFC (10.1+/-1.5) (p<.0001) and the LFV is L1 or L2 in the IVIP group and L3 or below in the control group (Table 1). At avg of 31-month f/u (min. 24m), no PLVT failure, AO, or RS was seen. In the lumbar spine, PLVT was done in avg 1.7+/-0.5 levels. Avg T12L5SBROM at pre-op ($25^\circ+/-11^\circ$) and at f/u ($28^\circ+/-14^\circ$) were not statistically different (p=.45) (Table 2). Avg post-op FEROM was $41^\circ+/-13^\circ$, within the normal range discussed in the literature. Avg SRS-22r score (n=7) at final f/u was 4.5/5 and pre-op was 4.0/5 (p<.01). DISCUSSION AND CONCLUSION:

Preserving ROM is one of the goals in PSS. The IVIP method can limit the SF to the apex of the main structural curve (SDL only) with fusionless PLVT of nSDLs resulting in significantly fewer levels fused compared to MHFC by saving nSDL from fusion, can be used for patients in all age groups including those at or near skeletal maturity, is safe, and preserves LS ROM, both SB and FE. We believe that the lumbar curve can be over-corrected with the IVIP method as one tries to do in anterior SF because the surgeon can control the position of each instrumented vertebra individually in space to correct the deformity at each disc angle level as one does in anterior SF. We hope that the IVIP method can promote a paradigm shift from global correction of spinal deformity to correction at each disc level in PSS to decrease the number of levels fused and preserve LS range of motion.







