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Assessing Spinal Motion at Different Fusion Levels in Adolescents with Idiopathic Scoliosis

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Introduction: Adolescent idiopathic scoliosis (AIS) is a three dimensional deformity of the spine. Surgery is warranted when conservative management is unable to control the spinal curve and Cobb angle(s) have exceeded 50°. Fusion with a posterior approach is the most common technique in correcting spine curvatures in children and adolescents with idiopathic scoliosis. The ultimate goal is to balance the spine while minimizing the number of vertebrae fused. Instrumentation and fusion alter spinal range of motion (ROM) however, there is on going debate over the impact of fusion level on ROM^{1,2}. The purpose of this study is to asses spinal ROM relative to the last instrumented vertebra (LIV) pre- and one year post-operatively.

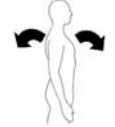
Methods: This is a prospective study of 40 participants who underwent posterior spinal instrumentation and fusion with a pre-operative Cobb angle > 50°. The participants were categorized into three groups based on the LIV: 14 participants (12 F, 2M, mean age 14.8 ± 2.4) had the fusion at L2 or above (L2+); 14 participants (11 F, 3M, mean age 13.3 ± 1.5) had the fusion at L3 (L3); and 12 participants (10 F, 2M, mean age 14.7 ± 2.0) had the fusion at L4 (L4). Participants were evaluated prior to surgery and approximately 12 months following spine fusion. Trunk ROM was assessed with a 3-Dimensional Motion Capture system (Vicon; Oxford, UK). While standing, the subjects were instructed to move their trunk maximally in all three planes (transverse, coronal and sagittal). Control Group data of 20 age-group matched typically developing adolescents was collected but not statistically compared. Repeated measure analyses of variance were performed to determine the effect of surgery and LIV on sagittal, coronal and transverse plane peak motion and ROM with significance set at p<0.05.

Results: All three groups (L2+, L3, L4) exhibited statistically significant post operative reductions in peak motion and ROM in all planes (Tables 1, 2, 3). When comparing within groups pre and post operatively, forward bending was significantly reduced by 33% for the L2+ group, 65% in the L3 group and 82% in the L4 group (Table 1). Contrasting the three groups revealed significant differences only in the sagittal plane post operatively. Controls had 58.7° of Forward Bending ROM, L2+ Post had 48% less than Controls, L3 Post had 46% less than L2+ Post and L4 Post had 54% less ROM than L3 Post (Table 1).

Conclusion: Fusing the spine in AIS caused significant ROM loss in all planes of motion regardless of fusion level compared to pre-op values. L4 fusions had the greatest ROM loss in the sagittal plane but statistically there is no difference between fusion levels in coronal or transverse plane motion.

Significance: These results highlight the impact of posterior fusion and LIV on motion of the spine in AIS. This quantitative assessment of spinal motion can assist surgeons in determining the appropriate LIV for patients undergoing posterior fusion.


Table 1. Degrees of Sagittal Spine Motion (stdev)

	L2+		L3		L4		Control
	Pre	Post	Pre	Post	Pre	Post	
Forward Bending	45.3(10.6)	30.3(12.8)	46.3(15.8)	16.2(15.2)*	43.0(18.6)	7.4(8.4)†	58.7(15.3)
Backward Bending	52.8(12.2)	37.8(8.8)	46.1(16.3)	39.8(9.1)	54.1(19.2)	38.2(9.0)	45.1(10.9)
Total ROM	99.5(13.4)	68.1(14.7)	92.5(21.0)	56.0(19.1)	97.1(24.5)	45.7(13.4)†§	103.5(10.3)

Statistical Significance ($p < 0.05$): *L2+ > L3, †L2+ > L4, § L3 > L4

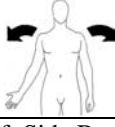
Note: Significance was found comparing within groups pre and post operatively for L2+, L3, and L4 during forward bending, backward bending and Total ROM

Table 2. Degrees of Transverse Spine Motion (stdev)

	L2+		L3		L4		Control
	Pre	Post	Pre	Post	Pre	Post	
Left Rotation	22.2(9.0)	10.8(5.9)	27.7(9.2)	12.6(6.6)	21.4(7.9)	14.7(4.4)	26.2(6.2)
Right Rotation	20.8 (7.6)	10.7(7.3)	24.6(11.7)	11.6(6.2)	21.5(6.3)	10.5(4.7)	26.2(7.2)
Total ROM	43.0(12.9)	21.6(11.1)	52.3(18.4)	24.2(9.8)	42.9(12.8)	25.3(7.2)	52.5(7.2)

Statistical Significance ($p < 0.05$): Significance was found comparing within groups pre and post operatively for L2+, L3, and L4 during left rotation, right rotation, and Total ROM

Table 3. Degrees of Coronal Spine Motion (stdev)

	L2+		L3		L4		Control
	Pre	Post	Pre	Post	Pre	Post	
Left Side Bending	43.4(8.8)	21.6(8.2)	45.7(13.0)	17.0(7.6)	40.5(9.9)	18.3(6.7)	41.6(7.3)
Right Side Bending	37.1(7.3)	22.4(7.4)	38.4(13.1)	17.8(6.1)	36.9(14.1)	20.4(5.2)	43.0(5.5)
Total ROM	80.5(14.3)	44.1(14.4)	84.2(24.4)	34.8(12.7)	77.4(21.4)	38.8(10.8)	84.6(6.1)

Statistical Significance ($p < 0.05$): Significance was found comparing within groups pre and post operatively for L2+, L3, and L4 during left side bending, right side bending, and Total ROM

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References:

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