

Is Crossing the Thoracolumbar Junction Necessary? Reevaluating Upper Instrumented Vertebra Selection to Minimize Proximal Junctional Complications

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INTRODUCTION:

The ideal choice for the upper instrumented vertebra (UIV) in adult spinal deformity (ASD) surgery continues to be debatable, particularly regarding whether to extend constructs above the thoracolumbar junction (TLJ). While some proponents suggest crossing the TLJ to minimize proximal junctional kyphosis (PJK) and associated complications, there is limited evidence supporting improved outcomes with this approach. Additionally, traditional definitions of PJK might fail to clearly distinguish between physiological and pathological variations in the TLJ area.

METHODS:

We conducted a retrospective propensity score-matched (PSM) cohort study of ASD patients who underwent instrumented fusion from either T11/T12 (above TLJ: ATLJ) or L1/L2 (below TLJ: BTLJ) to the sacrum or pelvis, with a minimum two-year follow-up. Patients with a prophylactic tether or prior fusions with a UIV above L3 were excluded. The primary outcomes were rates of proximal junctional pathology, including PJK (defined as $PJA \geq 10^\circ/\Delta PJA^\circ$), PJF (defined as $PJA \geq 28^\circ/\Delta PJA \geq 22^\circ$ or proximal extension of fusion), and abnormal PJA (defined as ≥ 2 SD from the normative mean for UIV location). PSM was performed based on demographics, preoperative alignment, and L1 pelvic angle (L1PA) correction.

RESULTS:

A total of 131 patients (88 females, 43 males; 84 ATLJ, 47 BTLJ) with a mean age of 65.3 (± 9.7) years, BMI of 28.8 (± 5.0) kg/m², and mean PI of 57.8° (± 11.4) were included, with an average follow-up of 2.3 years. In the ATLJ group, 72 (86%) had UIV at T11 and 12 (14%) at T12; in the BTLJ group, 21 (46%) had UIV at L1 and 25 (54%) at L2. The rate of PJK was significantly higher in the ATLJ group compared to BTLJ (67% vs. 32%, $p < 0.001$). Rates of PJF (20% ATLJ vs. 15% BTLJ, $p = 0.4$) and abnormal PJA (45% vs. 51%, $p = 0.5$) were not significantly different between groups. After PSM, 34 patients in each group were well-balanced (ATLJ: T11/T12, 88%/12%; BTLJ: L1/L2, 56%/44%). The ATLJ group continued to demonstrate a higher rate of PJK (68% vs. 32%, $p = 0.004$), while PJF (21% vs. 12%, $p = 0.3$) and abnormal PJA (31% vs. 47%, $p = 0.6$) rates remained comparable. Stratified analyses by specific UIV showed no significant differences in PJF ($p = 0.55$) or abnormal PJA ($p = 0.34$) between groups.

DISCUSSION AND CONCLUSION:

Fusing to the pelvis with a UIV of L1 or L2 is an acceptable strategy in ASD surgery, as the true rates of proximal junctional pathology—including PJK, PJF, and abnormal PJA—are similar to those observed when constructs cross the TLJ. The higher observed rate of PJK in ATLJ patients may reflect limitations of current PJK definitions in distinguishing pathologic from mechanical changes at the TLJ, rather than indicating a true clinical disadvantage.

Table 1: Comparison of demographics and radiographical data between ATLJ and BTLJ groups after PSM.

	ATLJ N = 34 ¹	BTLJ N = 34 ¹	p-value ²
Age	66 (61, 71)	70 (59, 74)	0.3
Gender (Female)	19 (56%)	23 (68%)	0.3
BMI	27.7 (26.2, 32.4)	27.7 (24.8, 30.5)	0.7
Osteoporosis	7 (21%)	7 (21%)	>0.9
Prior Fusion (Yes)	8 (24%)	6 (18%)	0.8
PI	54 (46, 65)	56 (49, 66)	0.4
Preop Max Cobb	26 (19, 32)	23 (18, 29)	0.5
Preop PT	23 (19, 28)	25 (20, 30)	0.2
Preop PI-LL	14 (5, 24)	17 (7, 25)	0.4
Preop T10-L2	-5 (-13, 3)	-2 (-10, 4)	0.5
Preop T4-T12	-33 (-40, -27)	-33 (-51, -26)	0.5
Preop L1PA offset	4.3 (0.5, 8.4)	6.9 (1.3, 9.1)	0.4
Preop T4-L1PA mismatch	4.1 (2.1, 9.6)	4.8 (3.0, 8.0)	0.7
Postop Max Cobb	9 (4, 19)	13 (9, 19)	0.2
Postop PT	20 (13, 25)	22 (19, 28)	0.12
Postop PI-LL	2 (-5, 4)	8 (2, 13)	0.001
Postop T10-L2	-13 (-18, -6)	-6 (-18, 2)	0.04
Postop T4-T12	-46 (-56, -39)	-41 (-54, -33)	0.12
Postop L1PA offset	1.2 (-1.1, 3.5)	1.6 (-0.9, 4.5)	0.4
Postop T4-L1PA mismatch	4.1 (1.7, 6.4)	4.2 (1.9, 6.6)	>0.9

¹ Median (Q1, Q3); n (%)

² Wilcoxon rank-sum exact test; Pearson's

Chi-squared test