Effects of Transitional Anatomy on Patient Outcomes Following the Antepsoas Oblique Lumbosacral Interbody Fusion

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INTRODUCTION: Transitional lumbosacral anatomy (TLA) is a spectrum of congenital variations ranging between lumbarization of the sacral vertebrae and sacralization of the lumbar vertebrae, with a prevalence nearing 30% in the general population. In lumbar fusion surgery, TLA may lead to technical challenges and therefore jeopardize achieving the desired arthrodesis and optimal lordosis. The minimally invasive antepsoas (MIS-ATP) approach has proven to be a safe and effective approach to lumbosacral arthrodesis, however its safety profile has not been specifically investigated in patients with TLA. This study sought to assess the rate of hardware-related, as well as vascular and neurological complications in patients with and without TLA who underwent MIS-ATP lumbosacral arthrodesis.

METHODS: This is a retrospective matched cohort study of adult patients with (126 patients) and without (177 patients) TLA who underwent MIS-ATP at a single institution between 2007 and 2019. Patients were matched by the extent of fusion (short vs long), sex, and age. Medical records and radiographs were reviewed to identify patient demographics, the presence of preoperative TLA, operative neurovascular complications, and postoperative rates of hardware failure and development of adjacent segment disease.

RESULTS: After adjusting for age, sex, BMI, and extent (long/short) of fusion, patients with transitional anatomy were found to have a 4.99 times greater risk of developing ASD than those without transitional anatomy (95% CI: 2.50-9.98, p<0.001) and a 2.77 times greater risk of developing peri-screw lucency (95% CI: 1.13-6.81, p=0.026). No differences in ASD rates between long fusion and short fusion (15.8% vs. 16.3%, p>0.999). And looking at Lumbarization vs Sacralization variants, there were no differences found regarding ASD rates (Lumbarized: n=13, 28.9% ; Sacralized: n=23, 28.4%, p>0.999) and Screw lucency rates (Lumbarized: n=5, 11.1%; Sacralized: n=9, 11.1%, p>0.999). Of the TLA-cohort patients who experienced screw lucency, none underwent subsequent screw lucency-driven revision procedures following the index operati ion. Of the 49 patients with ASD in both TLA and non-TLA groups, eight patients, all within the TLA cohort, underwent a revision procedure (16%).

DISCUSSION AND CONCLUSION: Presence of TLA in patients undergoing MIS-ATP fusion, while not predisposing to intraoperative neurovascular events, is associated with an increased risk of ASD compared to non-TLA patients. Diligent preoperative radiographic screening of TLA and subsequent patient counseling are therefore paramount in establishing reasonable patients' expectations, operative planning, and post-surgical follow up.

Figure 1: Standard Anatomy Patient with L4-S1 Fusion.

Figure 2: Lumbarized S1 with L5-S1-S2 Fusion.

Figure 3: Incompletely sacralized L5 with L4-S1 Fusion.

Table 1. Patient Demographics.

	Total cohort (N=402)	Non-Transitional (n=177)	Transitional (n=126)	p-value
Demographics				
Age (yrs)	54.91±11.97	56.23±12.64	55.06±11.06	**0.023**
Females	165	100	65	0.466
Operative Variables				
Short/Long Fusion				0.663
Short	202	114	88	
Long	101	63	38	
Lifestyle Factors				
Smoking				<0.068
Never	159	98	61	
Former	56	23	31	
Current	80	54	34	
BMI (kg/m^2)	31.01±8.33	31.26±6.49	30.65±0.09	0.415

Table 2: Short and Long Fusion Stratification.

	Short Fusion (n=202)					Long Fusion (n=101)				
	Total	Non-Transitional (n=114)	Transitional (n=88)	p-value		Total	Non-Transitional (n=63)	Transitional (n=38)	p-value	
Demographics										
Age (yrs)	51.44±10.83	52.48±11.21	50.08±10.28	0.119		61.86±11.73	63.00±11.75	59.97±9.71	0.145	
Females	108	60	42	0.123		55	32	23	0.436	
Lifestyle Factors										
Smoking				0.210					**0.007**	
Never	103	56	47			56	42	14		
Former	27	16	11			19	7	12		
Current	62	40	22			26	14	12		
BMI (kg/m^2)	30.90±4.23	30.89±4.16	30.91±4.31	0.980		31.22 ±6.98	31.92±7.05	30.05±5.6	0.170	

Table 3. Distribution of Transitional Anatomy.

Characteristic	N (%)
Sacralization of L5	59 (46.83%)
Lumbarization of S1	29 (23.02%)
Partial Sacralization of L5	22 (17.46%)
Partial Lumbarization of S1	16 (12.70%)

Table 4: Logistic Regression of Transitional Anatomy on Complications.

Characteristic	Odds Ratio	P-Value
Pseudarthrosis	1.05 (0.48, 1.00)	0.100
Hardware Failure	2.31 (0.04, 4.78)	0.072
ASD	3.84 (2.49, 10.21)	**<0.001**
Spondylolisthesis	1.41 (0.62, 1.66)	0.834
Degenerative spondylolisthesis (for revision examination)	1.75 (0.67, 3.38)	0.122
Degenerative Scoliosis	2.32 (0.42, 4.88)	0.268
Stenosis with advanced arthritis	0.89 (0.06, 1.05)	0.767
Post-discectomy syndrome (Failed Back Surgery Syndrome)	0.84 (0.26, 1.05)	0.385
Hardware Failure- Screw lucency	2.77 (1.13, 6.47)	**0.026**
Hardware Failure- PJK	-0.10 (0.00, inf)	-0.99
Hardware Failure- Hardware removal	-0.10 (0.00, inf)	-0.99
neurological complication	-0.10 (0.00, inf)	-0.99
wound dehiscence	-0.10 (0.00, inf)	-0.99
revision (Same Incision) Surgery	0.82 (-0.65, 0.87)	0.219
Pelvic Incidence	1.10 (-1.65, 1.71)	0.115

Adjusted for age, sex, BMI, and long/short fusion

Table 4: Complication Rates Stratified by Lumbarization and Sacralization (note: 1 condition/patient and normal for those)

Characteristic	Lumbarization (n=42)	Sacralization (n=82)	P-value
ASD rates	13 (28.9%)	23 (28.4%)	>0.999
Screw Lucency	5 (11.1%)	9 (11.1%)	>0.999

Characteristic	Lumbarization (n=29)	Partial Lumbarization (n=16)	Partial sacralization (n=22)	Sacralization (n=59)	P-value
ASD rates	10 (34.5%)	3 (18.8%)	7 (31.8%)	16 (27.1%)	0.760