Clinical Application of a Novel Psoas Muscle Classification System and Its Relationship to Adjacent Neurovascular Structures in Patients with Low-Grade Degenerative Spondylolisthesis

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INTRODUCTION: Oblique lumbar interbody fusion (OLIF) and lateral lumbar interbody fusion (LLIF) are commonly used to treat L4–L5 degenerative spondylolisthesis. The Emami et al. classification stratifies psoas muscle morphology at L4–L5 into three categories: Class A (>2 mm anterior to L4), Class B (≤2 mm anterior/posterior to L4), and Class C (>2 mm posterior to L4). While this classification may help guide surgical approach selection, no study has previously correlated it with neurovascular complication rates. This study evaluates whether psoas morphology predicts approach-specific neurovascular complications in OLIF and LLIF.

METHODS: A retrospective review was conducted on 350 patients who underwent single-level OLIF (n=178) or LLIF (n=172) at L4–L5 between 2012 and 2022 for low-grade degenerative spondylolisthesis. Preoperative axial T2-weighted MRIs at the inferior endplate of L4 were reviewed to assign psoas morphology using the Emami classification. Neurologic and vascular complications were recorded and analyzed using multivariable logistic regression, stratified by surgical approach and psoas class.

RESULTS: Neurologic complications were significantly more frequent following LLIF than OLIF (13.4% vs. 2.8%, p<0.001), particularly in Class A patients (16.4% LLIF vs. 2.3% OLIF, p<0.001). In contrast, Class C patients had fewer neurologic injuries with LLIF (2.1%) than OLIF (8.9%) (p=0.019). Vascular complications were more frequent in OLIF than LLIF (5.1% vs. 1.2%, p=0.026), especially in Class C (13.3% OLIF vs. 1.8% LLIF, p=0.011). Logistic regression revealed that Class A predicted neurologic injury with LLIF (OR 4.52, p<0.001), while Class C predicted vascular injury with OLIF (OR 5.29, p=0.003).

DISCUSSION AND CONCLUSION: Psoas morphology, as defined by the Emami classification, is a significant predictor of neurovascular complications based on surgical approach. Class A anatomy favors OLIF due to reduced neurologic risk, while Class C favors LLIF due to decreased vascular risk. Class B presents intermediate risk for both approaches. Preoperative psoas classification may guide safer and more effective surgical planning for L4–L5 interbody fusion.
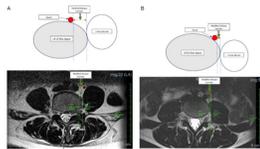

Figure 1. (A) An example of a class A psoas morphology demonstrating an open, positively valued modified oblique corridor. (B) An example of class C morphology demonstrating a narrow, closed, modified oblique corridor.
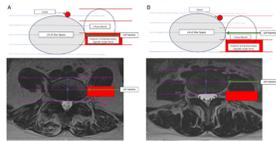

Figure 2. (A) An example of a class A psoas morphology demonstrating a dangerous LLIF trajectory. (B) An example of class C psoas morphology demonstrating a safe LLIF trajectory. LLIF indicated lateral lumbar interbody fusion.

Table 1. Oblique Corridor Dimensions and Simulated LLIF Trajectory by Psoas Morphology

Variable	Class A (n=141)	Class B (n=107)	Class C (n=102)	p-value
Mean Oblique Corridor, mm (± SD)	10.1 ± 2.3	6.4 ± 2.1	3.1 ± 1.7	< 0.001
Zero/Negative Corridor, n (%)	2 (1.4)	7 (6.5)	21 (20.6)	< 0.001
"Danger Zone" Intersected, n (%)	46 (32.6)	10 (9.3)	1 (1.0)	< 0.001

LLIF, lateral lumbar interbody fusion; SD, standard deviation. P-values were calculated using one-way ANOVA for continuous variables and Pearson's chi-square test for categorical comparisons. Bolded values indicate statistical significance at p < 0.05

Table 2. Complication rates stratified by surgical approach and psoas morphology.

Outcome	OLIF (n=178)	LLIF (n=172)	p-value
Nerve-Related Complications, n (%)	5 (2.8)	23 (13.4)	< 0.001
Transient Sensory Deficit, n (%)	2 (1.1)	11 (6.4)	
Transient Motor Deficit, n (%)	2 (1.1)	8 (4.7)	
Persistent Motor Deficit, n (%)	1 (0.6)	4 (2.3)	
Class A, n (%)	2 (2.0)	9 (22.0)	< 0.001†
Class B, n (%)	2 (4.2)	6 (10.2)	0.175†
Class C, n (%)	1 (3.3)	1 (1.4)	0.596†
Vascular Complications, n (%)	9 (5.1)	2 (1.2)	0.036
Class A, n (%)	1 (1.0)	0 (0.0)	0.458†
Class B, n (%)	2 (4.2)	1 (1.7)	0.889†
Class C, n (%)	6 (20.0)	1 (1.4)	0.008†

Nerve-related complications included persistent sensory or motor deficits beyond three months.
Vascular complications included any vessel injury requiring repair or hematoma drainage.
† Fisher's exact test was used to compare OLIF versus LLIF within each psoas class.
Bolded values indicate statistical significance at p < 0.05