

Additional file 1. Supplementary tables and figure

Three-Month Leg Pain and Failure to Achieve the 1-Year ODI MCID After Unilateral Biportal Endoscopic Lumbar Interbody Fusion

Supplementary Table S1. Functional-form, endpoint, cohort-ascertainment, and five-domain deficit-burden analyses.

Analysis	Estimate	95% CI/range	P value	Additional metric	Interpretation
Four-knot RCS vs linear	LR $\chi^2=11.49$	—	0.003	Corrected AUC 0.910	Exploratory ordinary-LR form diagnostic; Firth performance.
Three-knot RCS (1, 2, 5) vs linear	LR $\chi^2=5.86$	—	0.016	Corrected AUC 0.907	Sensitivity analysis suggested a similar nonlinear pattern.
Conventional linear-logit model	OR 4.51 per point	2.88–7.08	<0.001	Multivariable average summary	Average association only; not constant across NRS.
Data-derived threshold model	OR 23.19	9.99–53.83	<0.001	NRS ≥ 3	Secondary; cutoff selected in this cohort.
MCID threshold 10	73 non-achievers	—	<0.001	Apparent Firth spline AUC 0.900	Robust to outcome threshold.
MCID threshold 12.8	77 non-achievers	—	<0.001	Apparent Firth spline AUC 0.928	Primary endpoint; apparent benchmark-plus-leg-pain RCS model corresponds to Table 4A.
MCID threshold 15	78 non-achievers	—	<0.001	Apparent Firth spline AUC 0.924	Robust to outcome threshold.
Continuous 1-year ODI	Partial F=22.40	—	<0.001	Descriptive R ² 0.137 → 0.371	Supports association beyond dichotomized MCID.
Surgery-system cohort ascertainment	282 possible ULIF records	—	—	274 confirmed; 234 eligible; 189 analyzed	8 non-ULIF, 40 clinically ineligible, and 45 incomplete-follow-up cases excluded; cutoff February 24, 2026.
Five-domain deficit-burden interaction	OR 0.87	0.36–2.08	0.753	Leg pain + burden + interaction	Descriptive minimally adjusted model; not full benchmark adjustment.
Study-defined functional dependence	30/189 (15.9%)	—	—	Preoperative Barthel Index <60	Primary operational definition used in all adjusted models.
Five-domain deficit distribution	82/68/27/11/1	—	—	0/1/2/3/4 deficits	Thirty-nine patients (20.6%) had ≥ 2 deficits.

AUC, area under the curve; CI, confidence interval; LR, likelihood-ratio; MCID, minimum clinically important difference; NRS, numerical rating scale; ODI, Oswestry Disability Index.

Supplementary Table S2. Marker and threshold selection frequencies across 10,000 marker-and-threshold selection bootstrap samples.

Stage	Marker	Selected cutoff	Count	Frequency among all samples	Conditional frequency	Interpretation
Marker selection	2-week back pain	-	0	0.00%	-	Never selected
Marker selection	2-week leg pain	-	0	0.00%	-	Never selected
Marker selection	3-month back pain	-	1	0.01%	-	Selected once
Marker selection	3-month leg pain	-	9,999	99.99%	-	Dominant selected marker
Threshold selection	3-month back pain	≥ 5	1	0.01%	100.00%	Conditional on its single selection
Threshold selection	3-month leg pain	≥ 2	2,036	20.36%	20.36%	Conditional on selecting 3-month leg pain
Threshold selection	3-month leg pain	≥ 3	7,954	79.54%	79.55%	Conditional on selecting 3-month leg pain
Threshold selection	3-month leg pain	≥ 4	9	0.09%	0.09%	Conditional on selecting 3-month leg pain

Each ordinary patient-level bootstrap sample was drawn with replacement from all 189 patients. Within every sample, the four candidate AUCs were recalculated, the highest-AUC marker was selected, and the maximum-Youden integer threshold was selected within that marker. Marker-level AUC ties were resolved by the fixed order used in the analysis code: 2-week leg pain, 2-week back pain, 3-month leg pain, and 3-month back pain. Ties between Youden-optimal integer cutoffs were resolved in favor of the lower cutoff. Random seed: 20260719. Conditional frequency uses the number of samples in which the corresponding marker was selected as the denominator.

Supplementary Table S3. Distribution of 3-month leg-pain NRS and ODI-MCID non-achievement events.

	3-month leg-pain NRS	Patients, n	Non-achievement events, n	Event rate
0		17	0	0.0%
1		47	1	2.1%
2		50	18	36.0%
3		29	19	65.5%
4		19	12	63.2%
5		9	9	100.0%
6		13	13	100.0%
7		3	3	100.0%
8		1	1	100.0%
9		1	1	100.0%

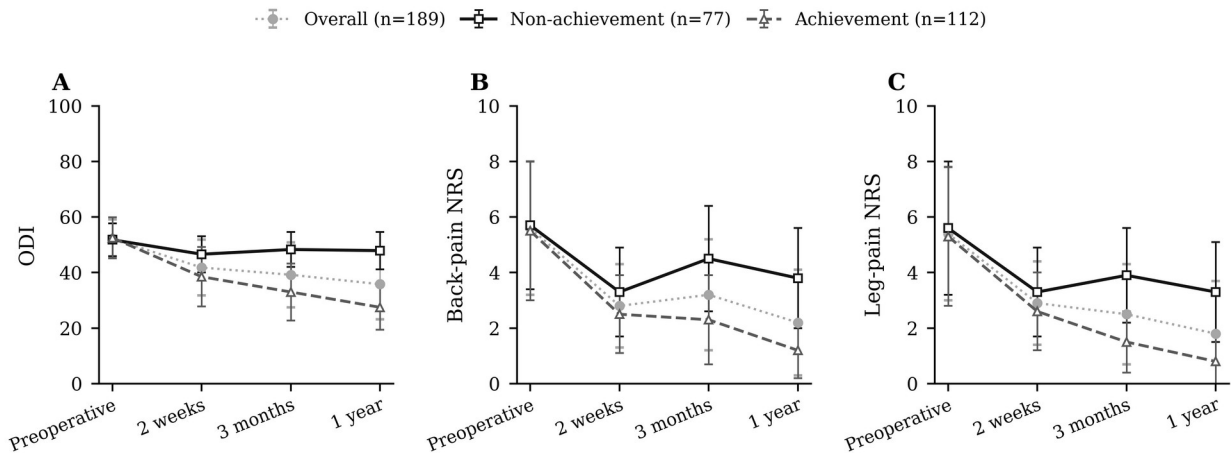
All 27 patients with NRS >=5 were non-achievers; therefore, estimates in the upper score range are separation-prone and should be interpreted cautiously.

Supplementary Table S4. Complete paired DeLong comparison matrix for the four candidate pain markers.

Marker 1	Marker 2	ΔAUC (1-2)	95% CI	Raw P	Holm-adjusted P	Interpretation
2-week back pain	2-week leg pain	0.037	-0.038 to 0.113	0.335	0.335	Not significant
2-week back pain	3-month back pain	-0.184	-0.256 to -0.112	<0.001	<0.001	Significant after Holm correction
2-week back pain	3-month leg pain	-0.260	-0.335 to -0.185	<0.001	<0.001	Significant after Holm correction
2-week leg pain	3-month back pain	-0.221	-0.297 to -0.146	<0.001	<0.001	Significant after Holm correction
2-week leg pain	3-month leg pain	-0.297	-0.372 to -0.222	<0.001	<0.001	Significant after Holm correction
3-month back pain	3-month leg pain	-0.076	-0.121 to -0.030	0.001	0.002	Significant after Holm correction

Differences are Marker 1 minus Marker 2. Confidence intervals and P values are from the paired DeLong implementation with Holm correction across all six comparisons.

Supplementary Figure S1. Trajectories of patient-reported outcomes during follow-up according to 1-year ODI-MCID status.



(A) Oswestry Disability Index (ODI), (B) back-pain numerical rating scale (NRS), and (C) leg-pain NRS at the preoperative, 2-week, 3-month, and 1-year assessments. Data are presented as mean +/- standard deviation for the overall cohort, the ODI-MCID non-achievement group, and the ODI-MCID achievement group. ODI, Oswestry Disability Index; MCID, minimum clinically important difference; NRS, numerical rating scale.