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Can Post-Procedural Improvement in the Lasegue Test After Transforaminal Epidural Steroid Injection Predict Long-Term Pain Relief? A Retrospective Study

Hüseyin Utku YILDIRIM

drutkuyil@gmail.com

Karadeniz Technical University

Erdem Nail DUMAN

Karadeniz Technical University

Esra KOÇ

Akdeniz University

Mert AKBAŞ

Akdeniz University

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Abstract

Purpose:

To evaluate whether early post-procedural improvement in the Lasegue test is associated with long-term pain relief following transforaminal epidural steroid injection (TFESI) in patients with lumbar disc herniation.

Methods:

In this retrospective study, 68 patients with lumbar disc herniation who underwent TFESI were included. The primary outcome was defined as a ≥ 50% reduction in Visual Analog Scale (VAS) score at 6 months. Change in Lasegue angle (post- minus pre-procedure) was evaluated as both a continuous and categorical variable. Logistic regression analysis was performed, and model performance was assessed using receiver operating characteristic (ROC) curves, calibration analysis, and bootstrap validation.

Results:

At 6 months, 75% achieved ≥ 50% pain reduction. Lasegue ≥ 30° strongly predicted success (OR 8.2, 95% CI 2.4–27.8, $p < 0.001$; sensitivity 68.6%, specificity 94.1%). Each 10° increase independently improved odds (OR 1.88, $p < 0.001$). A dose–response relationship was present (p for trend < 0.0001). Predictive value was enhanced in central protrusion and L4–L5. The model showed excellent discrimination (AUC 0.91) and good calibration, with similar results after bootstrap validation.

Conclusion:

Early improvement in the Lasegue test was associated with long-term pain relief following TFESI. A ≥ 30° increase may serve as a practical threshold to help identify patients more likely to benefit from the procedure.

INTRODUCTION

Lumbar disc herniation is a major cause of radicular pain and functional limitation worldwide [1]. Transforaminal epidural steroid injection (TFESI) has become a cornerstone in the non-surgical management of radicular symptoms, offering both diagnostic and therapeutic benefits [2]. Despite its widespread use, clinical outcomes vary considerably, and identifying reliable predictors of treatment success remains a significant challenge. Despite widespread use of TFESI, there is still no simple and reliable bedside predictor of long-term treatment success [3].

The Lasegue test (straight leg raise test) is a well-established clinical tool used to assess nerve root irritation. While its diagnostic utility is widely accepted, its potential role as a prognostic marker has not been systematically investigated [4, 5]. Improvement in Lasegue angle following TFESI may reflect reduced mechanical compression and improved neural dynamics, potentially correlating with long-term pain relief [6, 7].

Therefore, this study aimed to evaluate whether post-procedural changes in Lasegue angle can predict clinically meaningful pain reduction following TFESI. Additionally, we sought to investigate the interaction between Lasegue improvement and anatomical factors such as herniation level and type, to better understand subgroup-specific effects.

METHODS

Study Design and Population

This retrospective observational study was conducted at the pain clinic of a university-affiliated hospital. Patients who underwent transforaminal epidural steroid injection (TFESI) for lumbar disc herniation–related radicular pain were consecutively included. Ethical approval was obtained from the local ethics committee. The study was conducted in accordance with the Declaration of Helsinki.

Inclusion criteria: patients aged ≥ 18 years; BMI < 35, presence of radicular pain defined as pain radiating along a dermatomal distribution consistent with lumbar nerve root involvement, accompanied by at least one positive clinical finding (positive straight leg raise test [Lasegue]); radiologically confirmed lumbar disc herniation; availability of a lumbosacral MRI report interpreted by a radiologist; treatment with transforaminal epidural steroid injection (TFESI) only; no corticosteroid use within the last 1 month; no change in medical treatment for pain following TFESI; a standardized TFESI protocol applied to all patients; and no history of surgery for lumbar disc herniation within the past 6 months.

Exclusion criteria: patients younger than 18 years; absence of radiological confirmation of lumbar disc herniation; lack of an available or adequately reported lumbosacral MRI; receipt of treatments other than transforaminal epidural steroid injection (TFESI); corticosteroid use within the last 1 month; any modification in medical therapy for pain following TFESI; non-standardized or variable TFESI protocols; history of lumbar spine surgery within the past 6 months; presence of spinal tumors, infections, or fractures; inflammatory rheumatologic diseases affecting the spine; severe neurological deficits; and incomplete clinical or follow-up data.

Clinical Assessment

Patients undergoing percutaneous interventional pain procedures were evaluated in the pain clinic for preprocedural assessment; in the preoperative holding area 30 minutes prior to transforaminal epidural steroid injection (TFESI); in the post-anesthesia care unit (PACU) 30 minutes after the procedure; in the

ward before discharge; and in the pain clinic at 1- and 6-month follow-up visits. At each evaluation, patients underwent a standardized physical examination, including assessment of the Visual Analog Scale (VAS), motor and sensory function, and the straight leg raise (Lasegue) test.

All procedures are performed in the operating room under C-arm fluoroscopic guidance by two experienced pain specialists. A standardized injectate consisting of 20 mg 0.5% bupivacaine, 4 mg dexamethasone, 40 mg triamcinolone, and 4 mL of 0.9% saline is administered, with a total volume of 2.5 mL per level, unless an individualized treatment plan is deemed necessary.

The primary outcome was defined as a clinically significant improvement, corresponding to a ≥ 50% reduction in VAS score at 1 month and 6 months compared with baseline.

The straight leg raise (Lasegue) test was performed immediately before and after the procedure by experienced clinicians using a standardized goniometric technique. The primary predictor variable was defined as the change in the Lasegue angle (post-procedure minus pre-procedure value). For patients whose Laseque test results were negative after the procedure, the test results were recorded as 90 degrees.

Variables

Demographic and clinical variables included age, sex, level of disc herniation (L3–4, L4–5, L5–S1), and herniation type (bulging, extrusion, foraminal, paracentral, and central protrusion) as determined from lumbosacral MRI reports.

Improvement in the Lasegue (straight leg raise) test was assessed using a standardized goniometric technique and analyzed both as a continuous variable and as a categorical variable using predefined thresholds (10–20°, 20–30°, 30–40°, and ≥ 40°). For the primary analyses, a clinically meaningful cut-off value of ≥ 30° was also evaluated.

Statistical Analysis

Descriptive statistics were presented as mean ± standard deviation (SD) for normally distributed variables and median (interquartile range [IQR]) for non-normally distributed variables. Categorical variables were expressed as counts and percentages.

Normality was assessed using the Shapiro–Wilk test. Group comparisons were performed using the Student's t-test or Mann–Whitney U test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate.

The association between improvement in the Lasegue (straight leg raise) test and clinical success was evaluated using logistic regression analysis. Both univariable and multivariable models were constructed, with results reported as odds ratios (ORs) and 95% confidence intervals (CIs).

To assess dose–response relationships, categorical Lasegue groups were analyzed using the Cochran–Armitage trend test.

Model discrimination was evaluated using receiver operating characteristic (ROC) curve analysis and quantified by the area under the curve (AUC). Sensitivity and specificity were calculated based on the optimal cut-off value determined by the Youden index.

Model calibration was assessed using calibration plots and the Hosmer–Lemeshow goodness-of-fit test.

Internal validation was performed using bootstrap resampling (1,000 iterations) to estimate optimism-corrected performance metrics.

Potential interaction effects between Lasegue improvement and herniation level and type were explored by including interaction terms in the regression models.

A two-sided p-value < 0.05 was considered statistically significant. All analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp, Armonk, NY, USA).

RESULTS

A total of 82 patients were excluded from the study for the following reasons: 40 patients had received additional caudal epidural steroid injection alongside TFESI, 18 had incomplete medical records, 2 had received intramuscular corticosteroid injections within the preceding month, 3 had undergone lumbar disc surgery within the last 6 months, 1 patient was under 18 years of age, 10 patients were excluded due to non-standardized injectable materials used during TFESI, and 8 patients had a body mass index (BMI) greater than 35. After applying these exclusion criteria, a total of 68 patients were included in the final analysis.

The mean age was 51.5 ± 14.2 years, with a slight male predominance (54.4%). The most commonly affected level was L4–L5 (50.0%), followed by L5–S1 (39.7%). The most frequent herniation type was central bulging (36.8%), followed by central protrusion (23.5%). The mean increase in Lasegue angle was 24.9 ± 12.6°, with a balanced distribution across predefined categories (Table 1).

Table 1
— Baseline Characteristics

Variable	Value
n	68
Age (mean ± SD)	51.5 ± 14.2
Male, n (%)	37 (54.4%)
Female, n (%)	31 (45.6%)
L3–4, n (%)	7 (10.3%)
L4–5, n (%)	34 (50.0%)
L5–S1, n (%)	27 (39.7%)
Pre-op VAS	7.6 ± 1.1
1-month VAS	1.4 ± 1.3
6-month VAS	1.9 ± 1.6
Lasegue improvement (°)	24.9 ± 12.6

Clinical Outcomes

At 1 month, 57 patients (83.8%) achieved ≥ 50% reduction in VAS score, while 51 patients (75.0%) maintained this level of improvement at 6 months.

Association Between Lasegue Improvement and Treatment Success

When analyzed as a continuous variable, each 10° increase in Lasegue angle was associated with significantly increased odds of achieving ≥ 50% pain reduction (OR 1.88, 95% CI 1.32–2.66, $p < 0.001$).

In categorical analysis, Lasegue improvement ≥ 30° was strongly associated with clinical success at 6 months (OR 8.2, 95% CI 2.4–27.8, $p < 0.001$), demonstrating moderate sensitivity (68.6%) and high specificity (94.1%).

Lasegue Categories and Dose–Response Relationship

A clear dose–response relationship was observed between Lasegue improvement and treatment success. Patients with greater Lasegue increases demonstrated progressively higher success rates (p for trend < 0.0001). Those with ≥ 40° improvement achieved the highest success rates (95%) (Table 2).

Table 2
Association Between Lasegue Categories And Clinical Success

Lasegue Increase	n	Success n (%)	OR	95% CI	P value
10–20°	20	14 (70.0%)	Ref	-	-
20–30°	12	10 (83.3%)	2.1	0.6–7.1	0.21
30–40°	18	16 (88.9%)	6.8	1.9–23.4	0.003
≥ 40°	18	17 (94.4%)	9.5	2.4–37.2	< 0.001

Subgroup Analyses

Patients with L4–L5 herniation showed significantly higher odds of clinical success (OR 2.6, p = 0.014), followed by L5–S1 (OR 2.2, p = 0.041).

Regarding disc herniation type, central bulging was the most common (n = 25, 36.8%), followed by central protrusion (n = 16, 23.5%) and paracentral protrusion (n = 16, 23.5%), while foraminal protrusion (n = 7, 10.3%) and extruded disc (n = 4, 5.9%) were less frequently observed. Central protrusion was associated with the strongest predictive value (OR 3.4, p = 0.006), while bulging showed a modest association (OR 2.0, p = 0.048). No significant association was observed for foraminal or extruded herniations (Table 3).

Table 3
Univariate Predictors of Clinical Success

Variable	OR	95% CI	p	Sens (%)	Spec (%)
Lasegue ≥ 30°	8.2	2.4–27.8	< 0.001	68.6	94.1
Age ≥ 50	2.3	1.1–4.9	0.032	72	60
L4–5	2.6	1.2–5.5	0.014	65	62
Central protrusion	3.4	1.4–7.9	0.006	68	72

Diagnostic Performance

Diagnostic performance analysis demonstrated that a Lasegue improvement threshold of ≥ 30° provided moderate sensitivity (68.6%) and high specificity (94.1%), whereas a ≥ 40° threshold increased specificity to 100% at the expense of sensitivity (Table 4).

Table 4
Diagnostic Performance of Lasegue Improvement

Cut-off	Sens (%)	Spec (%)	PPV (%)	NPV (%)	AUC	P value
≥ 30°	68.6	94.1	97.2	50.0	0.91	< 0.001
≥ 40°	33.3	100	100	33.3	-	-

Model Performance and Validation

The predictive model demonstrated excellent discrimination, with an area under the curve (AUC) of 0.91 on ROC analysis (Fig. 1). Calibration analysis showed good agreement between predicted and observed outcomes (Fig. 2). Forest plot analysis confirmed the independent effect of Lasegue improvement and other covariates (Fig. 3).

Bootstrap validation showed similar AUC values, confirming model robustness

DISCUSSION

In this study, we found that post-procedural improvement in the Lasegue test was strongly associated with clinically meaningful pain reduction following TFESI. Notably, this association appeared to be more robust at 6 months than at 1 month, suggesting that early changes in Lasegue improvement may reflect long-term neural recovery rather than only short-term symptom relief.

From a clinical perspective, TFESI is widely used in the management of radicular pain due to lumbar disc herniation. Although many studies have reported favorable outcomes, long-term results remain heterogeneous. Previous studies have demonstrated that TFESI provides significant pain decrease in patients with lumbar disc herniation, particularly in the short to mid-term period. However, long-term outcomes remain variable. In a study, 75.29% of patients experienced more than a 50% reduction in pain after 3 months compared to their baseline values[8]. In another study with a follow-up exceeding 4 years, complete resolution of radicular pain was observed in approximately 45% of patients, although a substantial proportion required additional interventions [9]. Similarly, long-term follow-up studies have reported sustained pain reduction, but with recurrence rates and ongoing treatment needs in up to 30% of patients [10]. These findings suggest that while TFESI offers meaningful long-term benefit, its effectiveness is heterogeneous and may depend on patient-specific and clinical factors. This variability highlights the need for simple and reliable predictors that can be used early after the procedure.

Traditionally, the Lasegue test has been considered primarily a diagnostic tool. However, our findings suggest that its dynamic change following intervention may also carry prognostic value. An increase in Lasegue angle after TFESI likely reflects improved nerve root mobility and reduced mechanical compression [11].

In this context, it is plausible that patients demonstrating greater improvement are those in whom both inflammatory and mechanical components of radicular pain have been more effectively addressed.

Unlike imaging-based predictors, which provide relatively static anatomical information, post-procedural Lasegue improvement represents a functional parameter. This distinction may partly explain why it showed a strong association with long-term outcomes in our cohort[12]. Functional recovery of the nerve root may be more directly related to symptom improvement than structural findings alone.

Discriminative Performance and Model Reliability

The predictive performance of Lasegue improvement was supported by multiple complementary analyses. ROC analysis demonstrated excellent discriminative ability, with an AUC of 0.91, indicating that the model reliably distinguishes between patients with and without clinically meaningful improvement.

In addition, calibration analysis showed good agreement between predicted and observed outcomes, suggesting that the model provides accurate probability estimates rather than merely separating outcome groups. This is particularly relevant for clinical applicability, as both discrimination and calibration are essential for a reliable predictive model.

Furthermore, bootstrap validation confirmed the robustness of the model, indicating that the observed predictive performance is unlikely to be due to overfitting. A clear dose–response relationship was observed between Lasegue improvement and treatment success. Patients with greater increases in Lasegue angle demonstrated progressively higher success rates, supporting a biologically plausible gradient effect. This finding supports the strength of the association and suggests that Lasegue improvement functions not only as a binary marker but also as a quantitative predictor of outcome.

Subgroup analyses provided additional insights. The predictive value of Lasegue improvement appeared to be more pronounced in patients with L4–L5 level herniation and in those with central protrusion. While previous literature has often reported inconsistent effects of herniation level and type on TFESI outcomes [13–15], our findings suggest that anatomical factors may still influence treatment response under certain conditions. The literature includes studies showing that transforaminal epidural steroid injections, administered to 370 and 1262 patients respectively for the treatment of foraminal and paramedian lumbar disc herniation, are more effective in paramedian disc herniation compared to foraminal disc herniation [16]. These findings can be explained by differences in biomechanical and anatomical characteristics. There is evidence ın the literature that structures such as the annulus, nerve roots, posterior longitudinal ligament, facet joints, tendons, ligaments, and fascia can cause pain and that suggesting that the distribution of pain generators is increased in the ventral lateral space [17–19]. The central bulging may have allowed a greater volume to reach the anterior epidural space compared to a foraminal or extraforaminal protrusion, and this volume may have enabled it to release adhesions and suppress inflammation more effectively.

Similarly, the L4-L5 level, the most frequently affected segment, may show more predictable responses to intervention. These findings may provide clinicians with insights into considering anatomical factors when interpreting early clinical response. Although the epidural space at the L5–S1 level may be wider and allow greater ventral spread of injectate [20], technical challenges—such as a narrower and more

obliquely oriented foramen and limited fluoroscopic visualization due to the iliac crest—may limit optimal needle positioning and effective drug delivery.

The identification of Lasegue improvement as a simple and reliable bedside predictor has important implications for clinical practice. Unlike advanced imaging or laboratory markers, the Lasegue test is universally available, cost-free, and easily reproducible.

The identification of a ≥ 30° threshold provides a practical and clinically actionable cut-off that can be used to stratify patients early after the procedure. This may assist clinicians in predicting long-term outcomes, optimizing follow-up strategies, and guiding patient counseling.

Previous studies investigating predictors of TFESI outcomes have primarily focused on imaging findings, baseline pain scores, or demographic characteristics. While these factors provide valuable information, they often fail to capture the dynamic functional recovery of neural structures.

Our findings add to the existing literature by demonstrating that a simple physical examination parameter can serve as a robust predictor of long-term outcomes. This supports a shift toward integrating dynamic clinical assessments into prognostic models.

Limitations

This study has several limitations. Its retrospective design introduces the possibility of selection bias, and the single-center setting may limit generalizability. In addition, some subgroups included relatively small numbers of patients, which may have reduced statistical power. Finally, although a standardized technique was used, inter-observer variability in Lasegue measurement was not formally evaluated.

CONCLUSION

In conclusion, post-procedural improvement in Lasegue angle is a strong, independent, and clinically meaningful predictor of long-term pain reduction following TFESI. Its consistent performance across discrimination, calibration, and effect size analyses supports its role as a practical bedside biomarker. The identification of a ≥ 30° threshold further enhances its clinical applicability.

Declarations

Author Contribution

Y, HU contributed to the study concept and design, performed the percutaneous interventional pain procedures, and was involved in data collection and patient follow-up. K, E conducted the statistical and analytical evaluation. D, EN contributed to manuscript drafting and clinical procedures. A, M served as clinical supervisor and contributed to study oversight. All authors read and approved the final manuscript.

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Figures

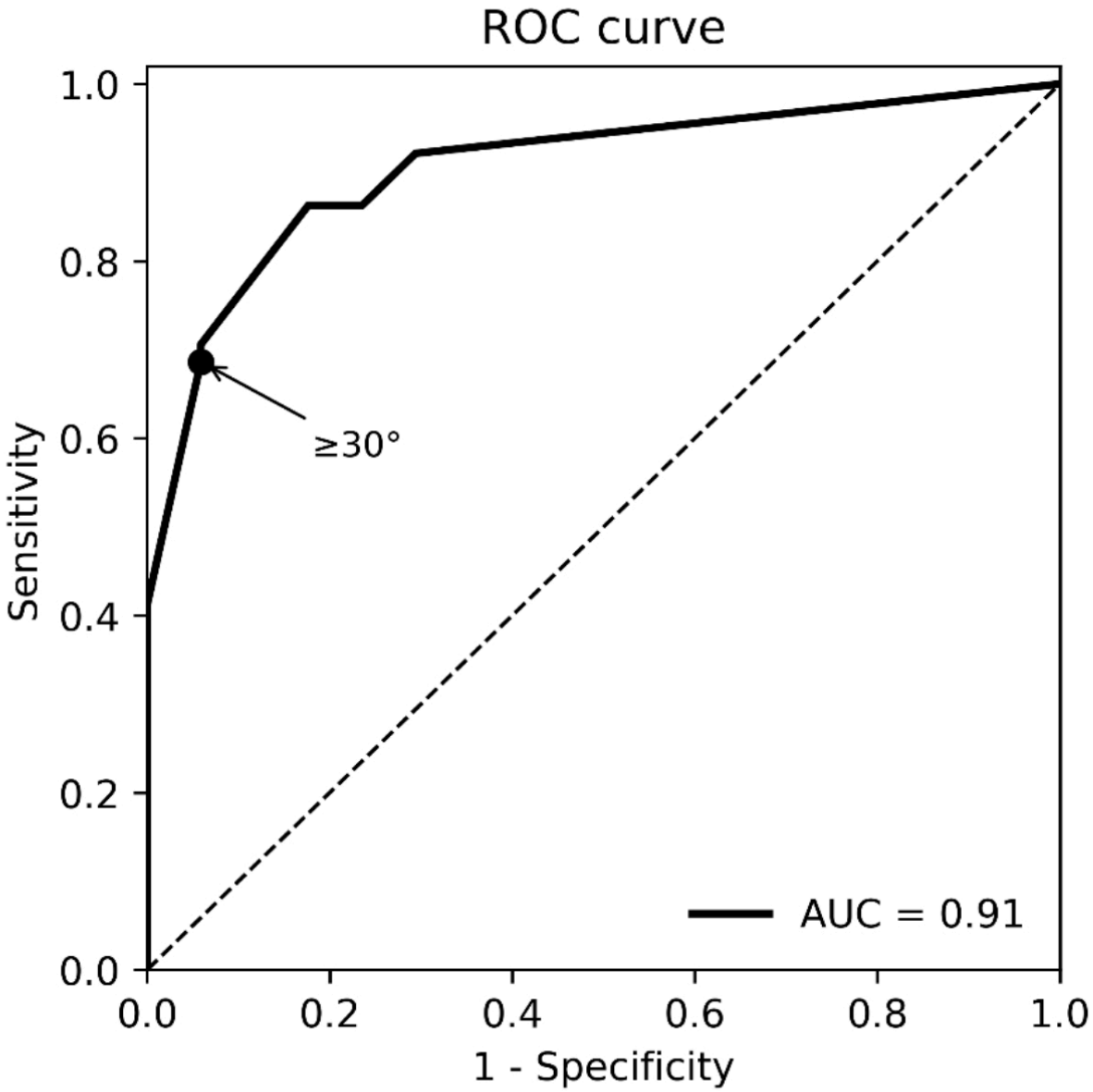


Figure 1

ROC Curve

Receiver operating characteristic (ROC) curve demonstrating the discriminative performance of Lasegue improvement in predicting ≥50% reduction in Visual Analog Scale (VAS) score at 6 months. The area under the curve (AUC) was 0.91, indicating excellent discriminative ability. The optimal cut-off value (≥30°) was determined using the Youden index, yielding a sensitivity of 68.6% and a specificity of 94.1%. Bootstrap validation showed similar AUC values, supporting the robustness of the model.

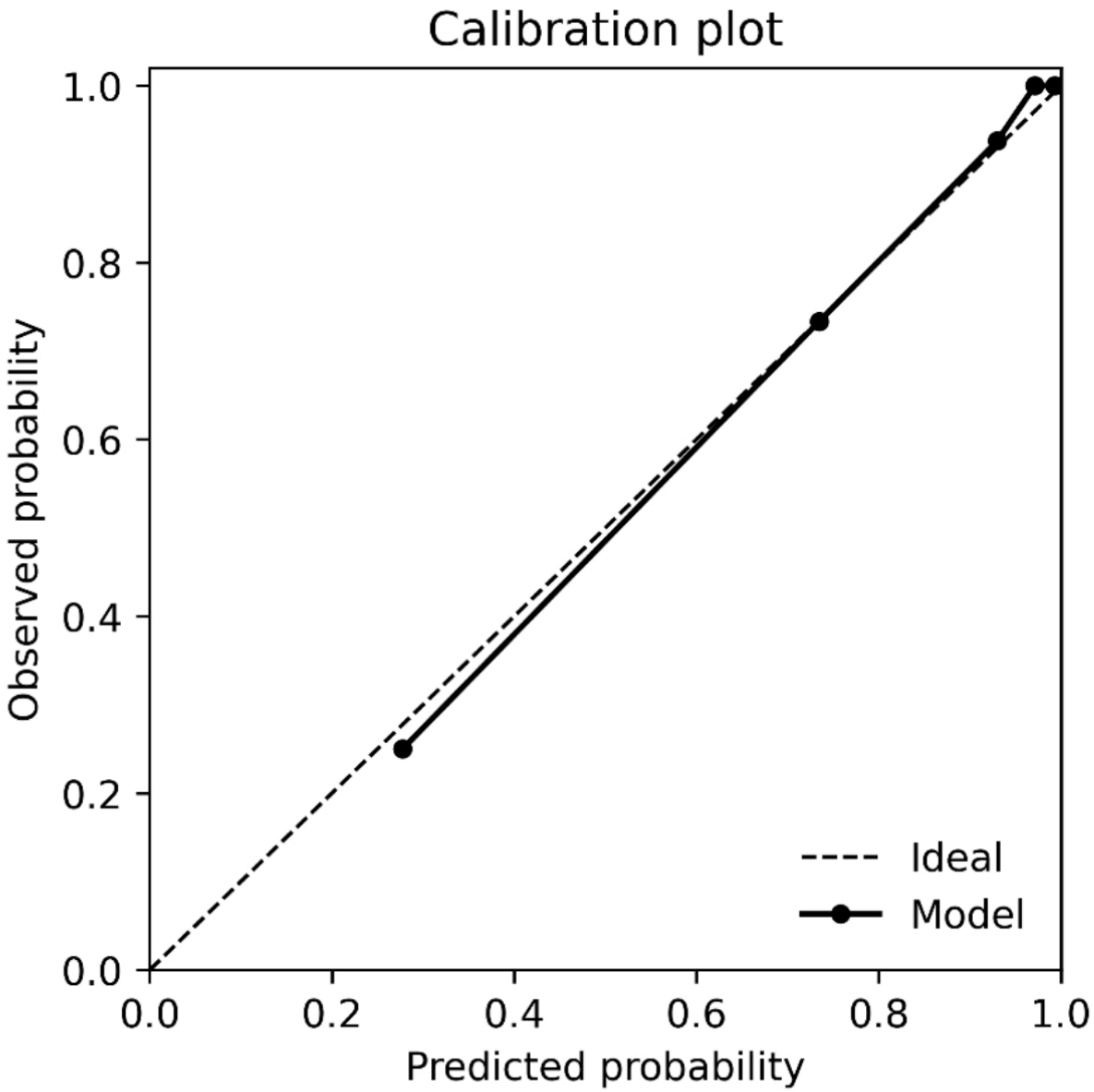


Figure 2

Calibration Plot

Calibration plot showing the agreement between predicted and observed probabilities of achieving ≥50% reduction in VAS score at 6 months. The plotted points demonstrate good alignment with the ideal 45° reference line, indicating good calibration of the model.

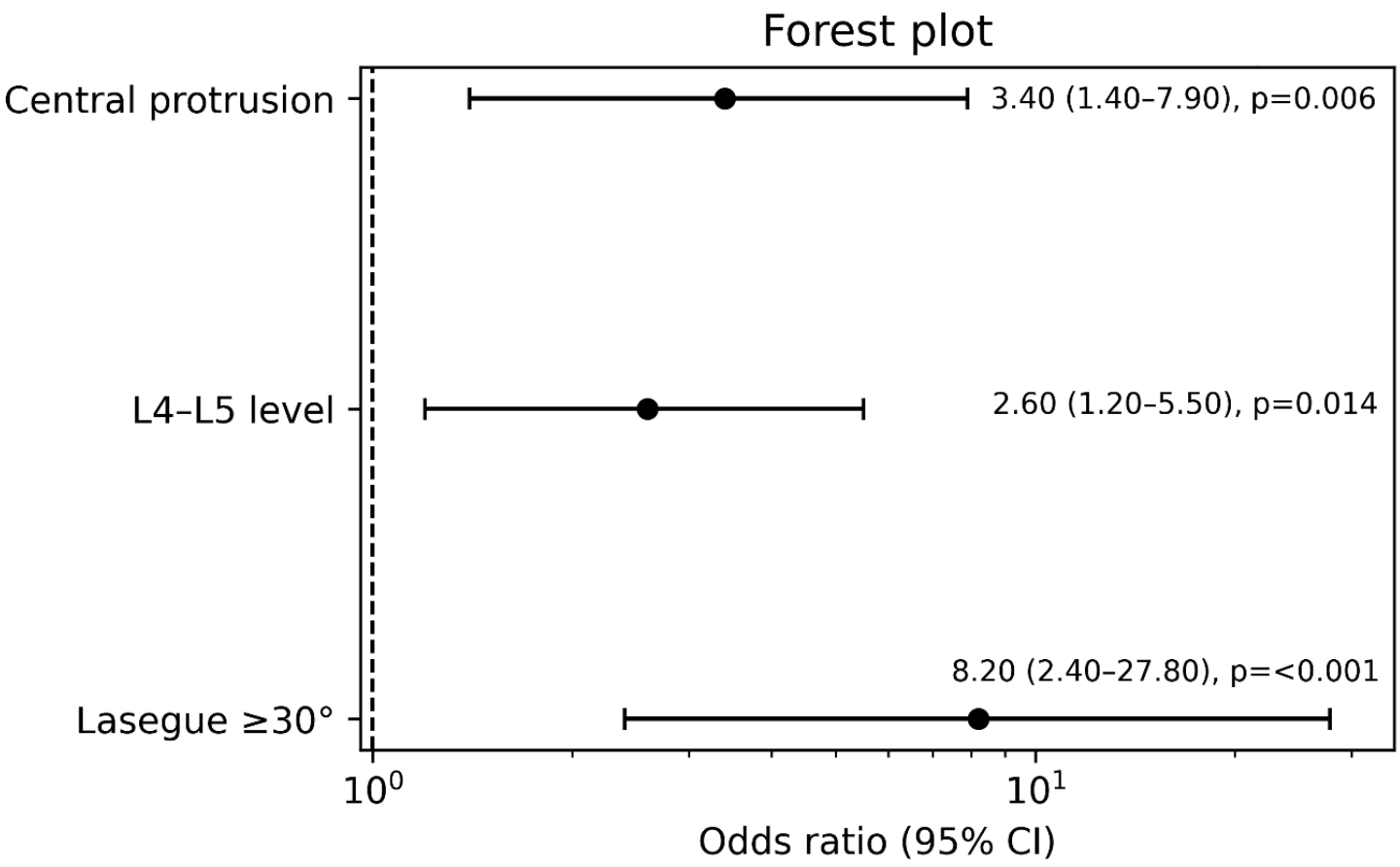


Figure 3

Forest Plot

Forest plot of univariate predictors of clinical success at 6 months. Odds ratios (ORs) with 95% confidence intervals (CIs) are shown for Lasegue ≥30°, L4–L5 level, and central protrusion