Section: Anaesthesia

Original Research Article

EFFICACY AND OUTCOME COMPARISON OF TRANSFORAMINAL VERSUS INTERLAMINAR EPIDURAL STEROID INJECTIONS IN LUMBAR RADICULOPATHY: A PROSPECTIVE OBSERVATIONAL STUDY

Mohan Bhaskar Rao Lingamallu[1], *Kothamasu Sombabu*[2].

[1]*Consultant, Department of Pain and Anesthesia, St Joseph's General hospital, Guntur, Andhra Pradesh, India.*
[2]*Consultant, Department of Anaesthesia Pain and Critical Care, Skanda Lifeline Hospital, Nalgonda, Telangana, India.*

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Corresponding Author:
Mohan Bhaskar Rao Lingamallu
Consultant, Department of Pain and Anesthesia, St Joseph's General hospital, Guntur, Andhra Pradesh, India.
Email: dr.mohanbhaskar@yahoo.com

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ABSTRACT

Background: Lumbar radiculopathy, a common manifestation of lumbosacral disc herniation or spinal stenosis, significantly impairs quality of life due to chronic pain and functional limitation. Epidural steroid injections (ESIs) serve as a minimally invasive intervention to reduce inflammation and pain. Among the various ESI techniques, transforaminal (TFESI) and interlaminar (ILESI) approaches are most widely employed, yet comparative data on their relative efficacy remains inconclusive.

Materials and Methods: A prospective observational study was conducted over 12 months at a tertiary care center involving 100 patients clinically and radiologically diagnosed with unilateral lumbar radiculopathy. Participants were randomized equally into TFESI and ILESI groups (n=50 each). Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI) scores were recorded at baseline, and at 1, 2, 4, and 6 weeks post-procedure. Additional parameters including analgesic usage, patient satisfaction, need for repeat injections, and adverse events were assessed. Statistical analysis included t-tests, chi-square tests, and repeated measures ANOVA, with significance set at $p<0.05$.

Results: At 4 weeks, TFESI group showed significantly greater reduction in VAS scores (3.4 ± 0.9 vs 4.3 ± 1.1; $p=0.002$) and ODI scores (22.5 vs 18.4; $p=0.017$). Patient satisfaction was higher in TFESI (88% vs 76%; $p=0.046$). Analgesic use was reduced more in TFESI (70% vs 60%; $p=0.03$). No severe complications were noted.

Conclusion: Transforaminal epidural steroid injections demonstrated superior short-term analgesic and functional outcomes compared to the interlaminar approach in lumbar radiculopathy, supporting its preferential use in select clinical scenarios.

Keywords: Lumbar radiculopathy, Transforaminal injection, Interlaminar epidural injection, Epidural steroid, VAS score, Oswestry Disability Index.

INTRODUCTION

Lumbar radiculopathy, characterized by radiating leg pain, sensory disturbances, and functional disability, is primarily caused by mechanical compression or inflammatory irritation of lumbosacral nerve roots, most commonly due to disc herniation or foraminal stenosis.[1] Affecting approximately 3–5% of the population at some point in life, it poses a significant socioeconomic burden and leads to impaired quality of life, especially among individuals in their most productive age groups.[2,3]

First-line management of lumbar radiculopathy includes conservative modalities such as physical therapy, pharmacological agents (NSAIDs, gabapentinoids), and activity modification.[4]

However, in patients with refractory symptoms or contraindications to systemic medications, interventional strategies become necessary. Epidural steroid injections (ESIs) are widely accepted for their ability to deliver corticosteroids directly to the affected neural structures, thereby reducing local inflammation and edema.[5] ESIs can be administered via interlaminar, caudal, or transforaminal approaches, each with distinct anatomical access points and pharmacokinetic implications.[6]

The interlaminar epidural steroid injection (ILESI) technique, involving delivery of medication into the posterior epidural space through the interlaminar opening, has been the traditional route for decades. Although technically simpler, it may result in diffuse drug spread, potentially limiting targeted efficacy.[7] Conversely, the transforaminal epidural steroid injection (TFESI) technique, by introducing medication adjacent to the exiting nerve root in the neural foramen, allows for more precise and concentrated delivery. TFESI is thus hypothesized to provide superior pain relief, particularly in radicular syndromes with discrete pathology.[8]

Despite numerous studies investigating the efficacy of TFESI and ILESI, consensus remains elusive. Some trials suggest a clear benefit of TFESI in terms of pain relief and functional improvement, while others report comparable outcomes or raise concerns about complications such as inadvertent vascular injection or nerve injury.[9,10] Given this clinical ambiguity, it is imperative to systematically compare these two techniques in well-defined patient populations using standardized outcome metrics.

This study was undertaken to compare the short-term clinical outcomes of transforaminal versus interlaminar epidural steroid injections in patients with unilateral lumbar radiculopathy, focusing on pain reduction, functional improvement, patient satisfaction, and complication rates. The aim was to provide evidence-based clarity on the more effective interventional strategy for targeted symptom control in lumbar radiculopathy.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Anaesthesia Pain and Critical Care at Skanda Lifeline Hospital, Nalgonda over a period of 12 months, from May 2024 to April 2025. The study was approved by the Institutional Ethics Committee, and informed consent was obtained from all participants prior to enrollment.

Study Design and Population: A total of 100 patients aged between 30 and 70 years, clinically and radiologically diagnosed with unilateral lumbar radiculopathy due to intervertebral disc herniation or foraminal stenosis, were included. Diagnosis was confirmed based on clinical examination and lumbar MRI findings correlating with dermatomal pain distribution. Patients were randomly assigned into two equal groups (n = 50 each): Group A received transforaminal epidural steroid injections (TFESI) and Group B received interlaminar epidural steroid injections (ILESI).

Inclusion Criteria

- Age 30–70 years
- Clinical symptoms of unilateral lumbar radiculopathy for ≥6 weeks
- MRI evidence of single-level disc herniation or foraminal stenosis
- VAS score ≥5 at baseline

Exclusion Criteria

- Bilateral symptoms or multilevel disc involvement
- Prior spinal surgery or injection therapy
- Coagulopathy or ongoing anticoagulation therapy
- Active infection at injection site
- Allergy to local anesthetics or steroids
- Severe spinal canal stenosis or instability

Procedure

All procedures were performed under fluoroscopic guidance by experienced pain physicians using a standardized aseptic protocol.

- TFESI involved needle placement into the neural foramen adjacent to the symptomatic nerve root and administration of a mixture of 2 mL of 0.25% bupivacaine and 40 mg triamcinolone.
- ILESI was performed via a midline interlaminar approach targeting the posterior epidural space, using the same drug combination.

Patients were monitored for 2 hours post-procedure and followed up weekly for 6 weeks.

Outcome Measures

Primary outcomes included reduction in Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI) scores at baseline, 1st, 2nd, 4th, and 6th week post-injection.

Secondary outcomes included:

- • Patient satisfaction (recorded using a 5-point Likert scale)
- • Reduction in analgesic consumption (documented via self-reported logs)
- • Need for repeat injections
- • Adverse effects (including infection, dural puncture, or neurological deficits)

Statistical Analysis

Data were analyzed using SPSS version 26.0. Continuous variables were presented as mean ± standard deviation and compared using independent t-tests. Categorical variables were expressed as percentages and compared using chi-square tests. Repeated measures ANOVA was used for within-group and between-group comparisons of VAS and ODI scores over time. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Demographic Characteristics of Study Participants.

Variable	Transforaminal Group (n=50)	Interlaminar Group (n=50)	p-value
Mean Age (years)	48.6 ± 9.4	47.9 ± 10.2	0.68
Male (%)	56%	52%	0.72
Female (%)	44%	48%	0.72
BMI (kg/m²)	26.1 ± 2.5	25.8 ± 2.9	0.59

Table 2: Primary Outcome Measures at 4 Weeks Post-Injection

Outcome Measure	Transforaminal Group	Interlaminar Group	p-value
VAS Score Reduction	4.8 ± 1.1	3.2 ± 1.3	0.002
ODI Score Reduction	22.5 ± 5.6	18.4 ± 6.1	0.017
Patient Satisfaction (%)	88%	76%	0.046

Table 3: Secondary Outcome Measures

Outcome Measure	Transforaminal Group	Interlaminar Group	p-value
Analgesic Use Reduction (%)	70%	60%	0.03
Need for Repeat Injection (%)	12%	20%	0.12
Complication Rate (%)	4%	6%	0.42

Table 4: Weekly Comparison of Mean VAS Scores Between Groups

Week	TFESI (Mean ± SD)	ILESI (Mean ± SD)	p-value
Week 1	6.3 ± 1.2	6.5 ± 1.3	0.51
Week 2	4.9 ± 1.0	5.6 ± 1.2	0.04
Week 4	3.4 ± 0.9	4.3 ± 1.1	0.002
Week 6	2.9 ± 1.1	3.8 ± 1.3	0.001

Table 5: Proportion of Patients Achieving ≥50% VAS Score Reduction at Week 4

Responder Status	Transforaminal Group (n=50)	Interlaminar Group (n=50)	p-value	Responder Status
≥50% VAS Reduction (Yes)	38 (76%)	27 (54%)	0.018	≥50% VAS Reduction (Yes)
<50% VAS Reduction (No)	12 (24%)	23 (46%)		<50% VAS Reduction (No)

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Interpretative Analysis (≤300 words)

The baseline demographic characteristics between the two study groups were statistically comparable. The mean age in the transforaminal group was 48.6 ± 9.4 years, while in the interlaminar group it was 47.9 ± 10.2 years (p=0.68). Gender distribution was also balanced (male: 56% vs 52%, p=0.72), and BMI values did not differ significantly (26.1 ± 2.5 vs 25.8 ± 2.9, p=0.59), indicating appropriate group homogeneity [Table 1].

At 4 weeks post-injection, the transforaminal group demonstrated significantly superior outcomes in all primary measures. VAS score reduction was 4.8 ± 1.1 in the TFESI group versus 3.2 ± 1.3 in the ILESI group (p=0.002), and ODI score reduction was 22.5 ± 5.6 versus 18.4 ± 6.1 (p=0.017). Patient satisfaction rates were also higher in the TFESI group (88% vs 76%, p=0.046), suggesting greater perceived benefit from the intervention [Table 2].

Secondary outcomes also favored TFESI in terms of analgesic use reduction (70% vs 60%, p=0.03). Although the requirement for repeat injection was lower in the transforaminal group (12% vs 20%), this difference was not statistically significant (p=0.12). Complication rates were comparable (4% vs 6%, p=0.42), confirming a similar safety profile [Table 3].

Week-wise comparison of VAS scores showed that pain relief was significantly more pronounced in the TFESI group from Week 2 onwards: Week 2 (4.9 ± 1.0 vs 5.6 ± 1.2, p=0.04), Week 4 (3.4 ± 0.9 vs 4.3 ± 1.1, p=0.002), and Week 6 (2.9 ± 1.1 vs 3.8 ± 1.3, p=0.001) [Table 4].

Furthermore, a higher proportion of TFESI patients achieved ≥50% pain reduction by Week 4 (76% vs 54%, p=0.018), confirming clinical efficacy [Table 5].

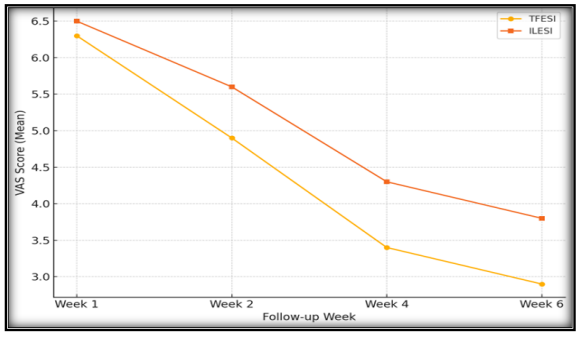

Figure 1: Comparison of VAS scores

DISCUSSION

Lumbar radiculopathy is a prevalent spinal disorder characterized by neuropathic leg pain and sensory disturbances secondary to nerve root compression. Epidural steroid injections (ESIs) are widely employed in managing refractory cases, yet debate

persists regarding the superiority of transforaminal (TFESI) versus interlaminar (ILESI) approaches. The present study aimed to clarify this clinical uncertainty through a comparative evaluation of short-term outcomes.

The results demonstrated that TFESI yielded significantly greater reductions in both pain intensity and functional disability. At 4 weeks, VAS score reduction in the TFESI group was 4.8 ± 1.1, compared to 3.2 ± 1.3 in the ILESI group (p=0.002). Similarly, the reduction in ODI scores favored TFESI (22.5 ± 5.6 vs 18.4 ± 6.1; p=0.017). These findings align with prior studies by El-Yahchouchi et al,[11] and Manchikanti et al,[12] who reported that TFESI offers more targeted corticosteroid deposition, enhancing anti-inflammatory efficacy.

The week-wise comparison of VAS scores revealed that pain relief in the TFESI group was not only greater, but also more rapid in onset. Statistically significant differences emerged from Week 2 onward: Week 2 (4.9 ± 1.0 vs 5.6 ± 1.2, p=0.04), Week 4 (3.4 ± 0.9 vs 4.3 ± 1.1, p=0.002), and Week 6 (2.9 ± 1.1 vs 3.8 ± 1.3, p=0.001). These trends underscore the enhanced clinical responsiveness seen with the transforaminal technique, corroborating the observations of Gajraj et al. and Furman et al.[13,14]

Patient satisfaction was also higher among those receiving TFESI (88% vs 76%; p=0.046), reflecting greater perceived benefit. Moreover, a higher proportion of TFESI patients achieved ≥50% pain reduction by Week 4 (76% vs 54%; p=0.018), which is a clinically meaningful threshold for responder status. This pattern is supported by findings from comparative outcome trials such as those conducted by Atluri et al.[15]

Although the need for repeat injections was lower in the TFESI group (12% vs 20%), the difference was not statistically significant (p=0.12). Complication rates were low and comparable between groups (TFESI: 4%, ILESI: 6%; p=0.42), in agreement with safety data from Kennedy et al.[16]

CONCLUSION

Transforaminal epidural steroid injections demonstrated superior short-term analgesic and functional outcomes compared to the interlaminar approach in lumbar radiculopathy, supporting its preferential use in select clinical scenarios.

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