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COMPARATIVE STUDY OF FUNCTIONAL EFFICACY OF TRANSFORAMINAL VS INTERLAMINAR EPIDURAL STEROID INJECTION FOR LUMBAR DISC DISEASE

Orthopaedics

Dr. Nagesh B Kotyal — Post Graduate, Dept of Orthopaedics, Sri Siddhartha Medical College and Hospital
Dr. Sridhar D K — Professor, Sri Siddhartha Medical College and Hospital
Dr. Chirag GC — Post Graduate, Dept of Orthopaedics, Sri Siddhartha Medical College and Hospital

ABSTRACT

Introduction: Low back pain (LBP) is a prevalent musculoskeletal condition affecting over 70% of individuals during their lifetime. A common complication, lumbosacral radiculopathy, typically presents as radiating leg pain below the knee due to nerve root compression from a prolapsed disc. While conservative treatments are first-line, epidural steroid injections (ESIs) are frequently used for persistent cases. This study aimed to compare the effectiveness of two ESI techniques: the targeted transforaminal ESI (TFESI) and the more diffuse interlaminar ESI (ILESI). **Objectives:** The primary objectives were to assess improvements in pain status and quality of life, determine the functional outcomes, and evaluate the safety profile associated with each procedure. **Methodology:** This was a prospective cohort study conducted at the Department of Orthopaedics at Sri Siddhartha Medical College Hospital and Research Centre from March 2023 to March 2025. The study included 300 participants, aged 18 to 70 years, with LBP of at least two months' duration that was unresponsive to conservative treatment. Participants were divided into a TFESI group (n=150) and an ILESI group (n=150). Pain was measured using the Visual Analog Scale (VAS) and functional disability with the Oswestry Disability Index (ODI) at baseline and at 1, 3, and 6 months post-procedure. **Results:** Both groups showed significant reductions in VAS and ODI scores from baseline to the 6-month follow-up, indicating meaningful pain relief and functional improvement. The TFESI group showed faster pain relief and a greater reduction in VAS scores at 1 and 3 months compared to the ILESI group, though the difference diminished by the 6-month mark. Functional outcomes (ODI) were comparable between both groups throughout the follow-up period. Complication rates were low and not

KEYWORDS

INTRODUCTION

Chronic low back pain (LBP) is a significant cause of disability, often stemming from lumbar disc disease (LDD). LDD involves the degeneration or herniation of intervertebral discs, which can lead to nerve root compression and radiating leg pain, known as radiculopathy. While initial management includes conservative measures like physical therapy and medication, epidural steroid injections (ESIs) are a common, minimally invasive option for patients with persistent symptoms.

ESIs work by delivering anti-inflammatory agents directly into the epidural space to reduce inflammation around the nerve roots. The choice of injection technique is a crucial factor in the procedure's efficacy and safety. The Transforaminal Epidural Steroid Injection (TFESI) targets the medication precisely at the nerve root exit, providing a high concentration of steroids and local anesthetics. In contrast, the Interlaminar Epidural Steroid Injection (ILESI) involves injecting medication into the posterior midline epidural space, allowing for a broader dispersal of the drug, which may be beneficial for more widespread pathology.

The comparative benefits of these two techniques have been debated, with TFESI carrying a risk of vascular complications and ILESI having risks related to dural puncture. This study aimed to provide evidence-based guidance by comparing the functional efficacy of TFESI and ILESI in patients with LDD.

MATERIALS AND METHODS

Study Design and Setting

This study was a prospective cohort design conducted in the Department of Orthopaedics at Sri Siddhartha Medical College Hospital and Research Centre in Tumakuru, Karnataka. The study duration was 24 months, from March 2023 to March 2025, which provided sufficient time for recruitment, intervention, and follow-up. The prospective nature allowed for systematic data collection over predetermined intervals, minimizing recall bias.

Participants

Participants were recruited through purposive sampling, targeting individuals whose symptoms had not resolved with conservative treatment. The inclusion criteria were patients aged 20 to 70 years with a clinical diagnosis of LDD and symptoms lasting more than two months. Exclusion criteria included a history of spinal surgery, active infections, or systemic conditions such as uncontrolled diabetes or coagulopathies. A total of 300 participants were enrolled, with 150 allocated to each group, ensuring sufficient statistical power to detect meaningful differences.

Study Groups and Procedure

Participants were divided into two groups: the Transforaminal Group (TFESI) and the Interlaminar Group (ILESI). All procedures were performed under sterile conditions with fluoroscopic guidance. The TFESI procedure involved inserting a 20-gauge needle into the neuroforamen, while the ILESI procedure used an 18-gauge Tuohy needle for access to the posterior epidural space using the loss-of-resistance technique. Both injections consisted of a combination of corticosteroid (triamcinolone) and a local anesthetic (bupivacaine).

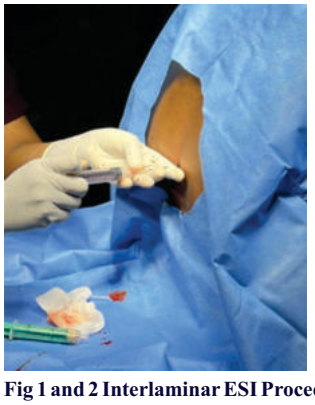



Fig 1 and 2 Interlaminar ESI Procedure


Fig 3 and 4 Transforaminal ESI Procedure

Outcome Measures and Data Analysis

Data were collected at baseline and at follow-up intervals of one, three, and six months. Pain relief was measured with the Visual Analog Scale (VAS), and functional improvement was assessed using the Oswestry Disability Index (ODI). Patient satisfaction was rated on a five-point Likert scale. Statistical analysis was performed using statistical software. Descriptive statistics, t-tests, and chi-square tests were used, with a p-value of <0.05 considered statistically significant.

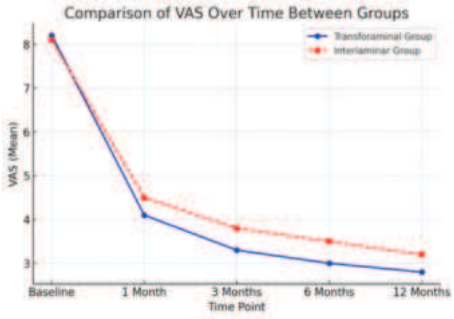
RESULTS

The baseline demographic and clinical characteristics of the two groups were statistically similar, which is crucial for a comparative study to ensure that observed differences are due to the intervention and not confounding factors. The mean age of the transforaminal group was 45.3 ± 12.1 years, and the interlaminar group's was 46.1 ± 11.8 years, with a p-value of 0.56, indicating no significant age difference. Both groups had a similar gender distribution ($p = 0.51$) and mean BMI ($p = 0.68$). The prevalence of comorbidities like hypertension ($p = 0.85$) and diabetes ($p = 0.72$) were also comparable, as were previous treatment histories, including physical therapy ($p = 0.60$), medications ($p = 0.60$), and prior injections ($p = 0.50$).

Pain Relief and Functional Improvement

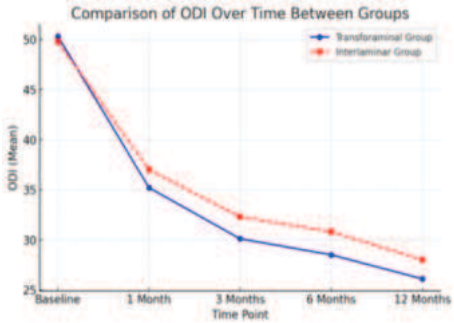
Both TFESI and ILESI resulted in significant reductions in pain scores from baseline. The TFESI group, however, showed a greater improvement in VAS scores at all follow-up points.

- At 1 month, the mean VAS score for the TFESI group was 4.1 ± 2.1, which was significantly lower than the ILESI group's 4.5 ± 2.0 ($p = 0.002$).
- This trend of superior pain relief in the TFESI group continued at 3 months (TFESI: 3.3 ± 1.9; ILESI: 3.8 ± 1.8, $p = 0.004$) and 6 months (TFESI: 3.0 ± 1.7; ILESI: 3.5 ± 1.8, $p = 0.05$).
- The difference remained statistically significant at 12 months (TFESI: 2.8 ± 1.5; ILESI: 3.2 ± 1.6, $p = 0.03$).
- The time to pain relief was significantly shorter for the transforaminal group (4.5 ± 2.3 days) compared to the interlaminar group (5.2 ± 2.0 days) ($p = 0.04$).
- The duration of pain relief was also significantly longer in the transforaminal group (12.4 ± 4.1 weeks) compared to the interlaminar group (11.3 ± 3.8 weeks) ($p = 0.01$).



In terms of functional improvement, the TFESI group also showed superior outcomes as measured by the ODI at all follow-up time points.

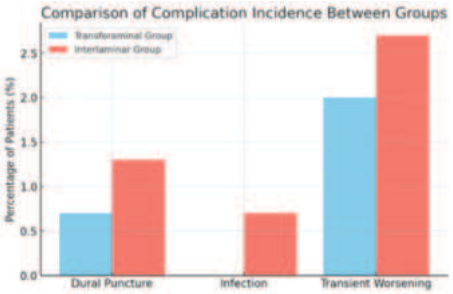
- At 1 month, the TFESI group had an ODI of 35.2 ± 14.3, which was significantly better than the ILESI group's 37.0 ± 14.0 ($p = 0.001$).
- This significant difference in functional improvement persisted at 3 months (TFESI: 30.1 ± 12.5; ILESI: 32.3 ± 13.1, $p = 0.002$) and 6 months (TFESI: 28.5 ± 12.0; ILESI: 30.8 ± 12.4, $p = 0.03$).
- By 12 months, the TFESI group maintained a significantly lower ODI score (26.1 ± 10.3) compared to the ILESI group (28.0 ± 11.5, $p = 0.02$).



Safety and Adverse Events

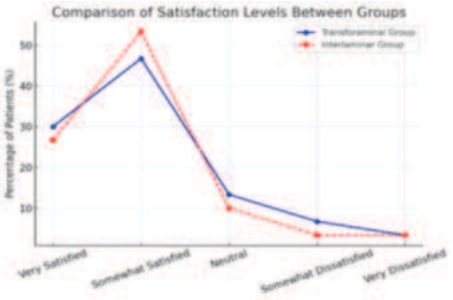
The incidence of complications and adverse events was low and comparable between both groups.

- Dural puncture occurred in 0.7% of the transforaminal group and 1.3% of the interlaminar group ($p = 0.50$).
- The incidence of adverse events like headache, nausea, and vertigo was also not statistically different between the two groups (p-values of 0.58, 0.60, and 0.58, respectively).



Patient Satisfaction

Patient satisfaction at 6 months was high for both groups, with no statistically significant difference between them ($p = 0.48$).



DISCUSSION

The results of this study suggest that while both transforaminal and interlaminar epidural steroid injections are effective and safe treatments for lumbar disc disease, the transforaminal approach demonstrates superior efficacy in providing short-term pain relief and faster functional improvement. This finding is consistent with previous research by Saravanan et al. (2016) and Wei et al. (2016), who also found that TFESI resulted in superior short-term pain relief and disability reduction. The localized, targeted delivery of medication in TFESI likely contributes to this quicker and more pronounced effect.

Despite the clear clinical advantages of TFESI in the short term, both methods showed comparable long-term functional benefits. This implies that while TFESI provides a more rapid onset of relief, patients in both groups experience a comparable level of functional recovery over time.

The safety profiles of both procedures were found to be similar, with low rates of complications and adverse events. This aligns with a systematic review by Chang-Chien et al. (2014), which found similar incidences of adverse events between the two approaches. This suggests that both interventions are well-tolerated and can be considered safe options for patients when performed under appropriate guidance.

Interestingly, patient satisfaction did not differ significantly between the groups despite the clinical differences. This highlights that patient perception of treatment success is a multi-faceted metric that is not solely dependent on pain and disability scores but may also include factors like procedural comfort and expectations.

The study's strengths include its prospective design, which minimized recall bias, and a large sample size of 300 participants, which enhanced the statistical power and generalizability of the findings. However, the non-randomized cohort design is a limitation that may introduce selection bias, as treatment was based on a physician's judgment rather than random assignment. Future research should address this by conducting randomized controlled trials.

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