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Edited by Vini Mehta

E-mail: vmehta@statsense.in

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Effectiveness of interlaminar and transforaminal approach for cervical epidural steroid injection in patients of chronic neck pain with radiculopathy

Jaideep Singh, Gautam Chandra Koshi*, Nupur Mourya & Sonal Awasya

Department of Anaesthesiology, Gandhi Medical College, Bhopal, Madhya Pradesh, India; *Corresponding Author

Affiliation URL:

<https://www.gmcbbhopal.net/>

Author contact:

Jaideep Singh - E-mail: singhdrjaideep@gmail.com; Phone: +91 9827767022

Gautam Chandra Koshi - E-mail: chandrakoshikmusic@gmail.com; Phone: +91 9575586607

Nupur Mourya - E-mail: nupurmourya787@gmail.com; Phone: +91 6232651270

Sonal Awasya - E-mail: awasyaa.84@gmail.com

Abstract:

Chronic neck pain with radiculopathy is a disabling condition that can significantly impair daily activities, work performance, and quality of life. Therefore, it is of interest to compare the interlaminar and transforaminal cervical epidural steroid injections in 80 patients aged 30–60 years with MRI-confirmed cervical radiculopathy, with 40 patients in each group. Pain relief was assessed using the Visual Analog Scale and Numerical Rating Scale, while functional outcome was measured using the Neck Disability Index and return-to-work status. Both techniques produced significant pain relief, but the transforaminal approach showed better targeted drug delivery and greater functional improvement, with stable hemodynamic parameters and only minimal complications. Thus, we show that both approaches are effective. However, transforaminal injection may offer superior pain relief and functional recovery in carefully selected patients.

Keywords: Cervical radiculopathy, epidural steroid injection, interlaminar approach, transforaminal approach, neck pain, VAS, NRS, functional outcome

Background:

Chronic neck pain is a major health concern worldwide and is one of the leading causes of disability and reduced work productivity, especially among people in the working-age group [1]. One important cause of chronic neck pain is cervical radiculopathy, which occurs when a cervical nerve root is compressed due to conditions such as intervertebral disc herniation, cervical spondylosis, or foraminal stenosis [2]. Patients commonly present with pain radiating to the arm, numbness, tingling, or weakness, which can interfere with daily activities and reduce quality of life [3]. In recent years, factors such as sedentary lifestyle, prolonged screen use, and poor posture have contributed to an increasing burden of cervical spine disorders [4]. Conservative treatment, including physiotherapy, oral medications, ergonomic correction, and lifestyle changes, is usually the first approach in managing cervical radiculopathy. However, many patients continue to experience persistent pain even after adequate conservative therapy [5]. For such patients, cervical epidural steroid injection has become an important minimally invasive treatment option. The aim of this procedure is to deliver corticosteroid medication into the epidural space, where it helps reduce inflammation, decrease nerve root irritation, and relieve pain [6]. Cervical epidural steroid injections are mainly performed using two approaches: interlaminar and transforaminal. In the interlaminar approach, the drug is injected into the posterior epidural space, from where it can spread across multiple spinal levels. This technique is relatively simple and commonly used, but because the drug spread is less targeted, its effectiveness may vary in some patients [7]. On the other hand, the transforaminal approach delivers the medication closer to the affected nerve root through the neural foramen. This allows more focused drug delivery and may provide better pain relief in selected cases [8]. Several studies have compared these two techniques, but the results have not been uniform. Some studies have reported better pain relief and functional improvement with the transforaminal approach because of its targeted action [9, 10]. Other studies suggest that both techniques are effective, while the interlaminar approach may have a lower risk of rare but serious complications such as vascular injury or spinal cord

infarction, which are more often associated with transforaminal injections [11]. The use of imaging guidance, especially fluoroscopy, has improved the accuracy and safety of both approaches [12]. Therefore, it is of interest to compare the efficacy of interlaminar and transforaminal cervical epidural steroid injections in patients with chronic neck pain and radiculopathy.

Materials and Methods:

Study design and setting:

This study was designed as an analytical, hospital-based observational study conducted at a tertiary care center. The objective was to compare the clinical efficacy of interlaminar (IL) and transforaminal (TF) approaches for cervical epidural steroid injection (CESI) in patients suffering from chronic neck pain with radiculopathy. The study was carried out over a period of 18 months, from June 2024 to November 2025, following approval from the Institutional Ethics Committee (IEC) (Letter No/16157/MC/IEC/2024, dated 06/05/2024). The study was prospectively registered under CTRI (CTRI/2025/03/081694). All procedures were performed in accordance with ethical standards and the Declaration of Helsinki.

Study population:

A total of 80 patients presenting with chronic neck pain associated with radiculopathy were included in the study. Patients were recruited from outpatient and inpatient departments based on predefined inclusion and exclusion criteria. Diagnosis of cervical radiculopathy was confirmed using magnetic resonance imaging (MRI), correlating clinical symptoms with radiological findings.

Inclusion criteria:

- [1] Patients aged between 30 and 60 years
- [2] Patients classified as American Society of Anaesthesiologists (ASA) physical status I and II
- [3] Patients with clinically and radiologically confirmed cervical radiculopathy
- [4] Patients willing to participate and provide written informed consent

Exclusion criteria:

- [1] Known hypersensitivity or allergy to corticosteroids or local anesthetic agents
- [2] Presence of significant systemic illness (cardiac, respiratory, hepatic, renal disease, diabetes mellitus, or hypertension)
- [3] Pregnant or lactating women
- [4] History of cervical spine surgery within the previous 6 months
- [5] Patients with coagulopathy or bleeding disorders

Study sampling:

A total of 80 patients were enrolled and equally allocated into two groups:

- [1] **Group A (Interlaminar group):** 40 patients
- [2] **Group B (Transforaminal group):** 40 patients

Pre-procedural assessment:

All patients underwent a detailed pre-procedural evaluation, including:

- [1] Comprehensive medical history and physical examination
- [2] Assessment of pain severity using Visual Analog Scale (VAS) and Numerical Rating Scale (NRS)
- [3] Evaluation of functional disability using Neck Disability Index (NDI)
- [4] Baseline recording of vital parameters: heart rate (HR), blood pressure (BP), oxygen saturation (SpO₂), and electrocardiogram (ECG)

Patients were counselled regarding the procedure, its benefits, risks, and possible complications. Written informed consent was obtained prior to intervention. Intravenous access was secured, and all patients received preloading with 500 mL of Ringer Lactate solution.

Intervention procedure:**Interlaminar epidural steroid injection (Group A):**

Patients were positioned prone on the fluoroscopy table with appropriate neck flexion supported by padding. After aseptic preparation using povidone-iodine, local infiltration with 1 mL of 2% lignocaine was administered. A 16-gauge Tuohy needle was inserted via a midline approach under fluoroscopic guidance. The epidural space was identified using the loss of resistance technique with normal saline. Correct needle placement was confirmed in both anteroposterior and lateral views. An epidurogram was performed using contrast medium (urografin) to ensure proper spread within the epidural space and to rule out intrathecal or intravascular injection. A mixture containing 4 mg dexamethasone (2 mL) and 3 mL of 0.5% lignocaine was slowly injected after negative aspiration and confirmation of appropriate contrast spread. Patients were monitored continuously throughout the procedure.

Transforaminal epidural steroid injection (Group B):

Patients were placed in a prone position with slight neck extension and head turned contralaterally. Under fluoroscopic

guidance, the C-arm was rotated 45°–60° to visualize the neural foramen optimally. Following aseptic preparation and local anesthesia, a 16-gauge spinal needle was advanced toward the posterior-inferior aspect of the neural foramen. Proper positioning was ensured by fluoroscopic imaging, taking care not to advance the needle beyond the mid-pedicular line in the anteroposterior view to avoid spinal canal entry. Contrast dye was injected under real-time fluoroscopy to confirm perineural and epidural spread without vascular or intrathecal uptake. Once confirmed, a solution containing 4 mg dexamethasone (2 mL) and 1.5 mL of 0.5% lignocaine was administered incrementally.

Post-procedural monitoring:

Following the injection, all patients were observed for a minimum period of 2 hours. Vital signs were monitored, and any immediate complications such as hypotension, allergic reactions, or neurological deficits were documented. Patients were discharged once clinically stable.

Outcome measures:**Primary outcome:**

Reduction in pain intensity measured using VAS and NRS scores

Secondary outcomes:

- [1] Improvement in functional status assessed using Neck Disability Index (NDI)
- [2] Return-to-work status
- [3] Incidence of complications
- [4] Pain and functional assessments were conducted at baseline and at regular follow-up intervals.

Observational parameters:

- [5] Hemodynamic variables (HR, MAP, SpO₂) recorded intra-procedurally at regular intervals
- [6] Pain scores (VAS, NRS) assessed at rest and during movement
- [7] Functional disability scores (NDI) evaluated during follow-up

Statistical analysis:

Data analysis was performed using SPSS software version 24.0. Continuous variables such as age, duration of symptoms, and baseline scores were expressed as mean $\pm$ standard deviation and compared using the Student's t-test. Categorical variables, including treatment success rates, were analyzed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant. The comparative effectiveness of IL and TF approaches was determined based on improvement in pain scores, functional outcomes, and

Results:

A total of 80 patients with chronic neck pain associated with cervical radiculopathy were included in the present study and equally allocated into two groups: Interlaminar (IL, n = 40) and Transforaminal (TF, n = 40). The results are presented in terms of demographic characteristics, hemodynamic parameters, and

pain scores. The age distribution was comparable between the two groups, with the highest proportion of patients in the 51–60 years category (37.5% in IL vs 40.0% in TF). The 30–40 years group had the lowest representation (27.5% in IL vs 25.0% in TF). The difference was statistically non-significant ($p = 0.876$), indicating homogeneity of age distribution. Gender-wise, a slight male predominance was observed in both groups (57.5% in IL and 55.0% in TF), while females constituted 42.5% and 45.0%, respectively. The difference in gender distribution was not statistically significant ($p = 0.986$), confirming comparability between groups (**Table 1**). Hemodynamic parameters remained stable throughout the observation period in both groups. Pulse rate showed minimal variation, with values remaining within physiological limits. At 24 hours, mean pulse was 72.27 ± 2.16 in the IL group and 73.38 ± 2.27 in the TF group, with no statistically significant difference ($p = 0.765$). Similarly, systolic blood pressure (SBP) values were comparable between groups, showing only minor fluctuations. At 24 hours, SBP was 120.23 ± 3.12 mmHg in IL and 121.34 ± 3.23 mmHg in TF ($p = 0.764$). Diastolic blood pressure (DBP) also demonstrated stable trends, with slightly higher values in the TF group across intervals, though not statistically significant ($p = 0.657$). Oxygen saturation (SpO_2) remained consistently above 97% in both groups at all-time intervals, indicating no respiratory compromise. The difference between groups was negligible and statistically non-significant ($p = 0.986$). Overall, both techniques were hemodynamically safe and comparable (**Table 2**). Both groups demonstrated a progressive reduction in pain scores over time, indicating the effectiveness of cervical epidural steroid injections. However, the TF group exhibited a significantly faster and greater reduction in pain compared to the IL group. At 15 minutes post-procedure, VAS decreased by approximately 18.9% in the IL group (from 8.91 to 7.23), whereas the TF group showed a reduction of nearly 41.1% (from 8.76 to 5.16). This early difference highlights the rapid onset of analgesia with the TF approach. At 60 minutes, the IL group showed a 38.8% reduction in VAS, compared to a 75.1% reduction in the TF group. By 6 hours, pain reduction reached 64.6% in IL versus 86.7% in TF. At 24 hours, both groups showed substantial improvement; however, the TF group achieved near-complete pain relief (VAS reduction of 98.0%) compared to 86.4% in the IL group. A similar trend was observed in NRS scores. At 24 hours, the IL group showed an 87.5% reduction, whereas the TF group demonstrated a 98.6% reduction in pain scores. The difference in pain reduction between the two groups was statistically highly significant ($p = 0.001$), indicating superior efficacy of the transforaminal approach in terms of both rapidity and magnitude of pain relief (**Table 3**).

Table 1: Demographic distribution of study participants			
Variable	IL Group n (%)	TF Group n (%)	p-value
Age (years)			
30–40	11 (27.5%)	10 (25.0%)	0.876
41–50	14 (35.0%)	14 (35.0%)	
51–60	15 (37.5%)	16 (40.0%)	
Gender			
Male	23 (57.5%)	22 (55.0%)	0.986
Female	17 (42.5%)	18 (45.0%)	

Table 2: Hemodynamic parameters (mean ± SD) at different time intervals

Parameter	Time	IL Group	TF Group	p-value
Pulse (beats/min)	Pre	75.14 ±2.13	76.25 ±2.24	0.765
	60 min	75.32 ±2.14	75.43 ±2.25	
	24 hr	72.27 ±2.16	73.38 ±2.27	
SBP (mmHg)	Pre	122.10 ±2.17	121.21 ±2.28	0.764
	60 min	121.15 ±4.14	122.26 ±4.25	
	24 hr	120.23 ±3.12	121.34 ±3.23	
DBP (mmHg)	Pre	82.14 ±2.13	84.25 ±3.21	0.657
	60 min	78.14 ±1.15	79.25 ±1.26	
	24 hr	81.26 ±1.14	82.37 ±1.25	
SpO ₂ (%)	Pre	97.21 ±3.12	97.32 ±3.23	0.986
	60 min	98.16 ±3.72	98.27 ±3.83	
	24 hr	98.23 ±4.13	98.34 ±4.24	

Table 3: Pain scores (VAS and NRS) at different time intervals

Time	VAS IL	VAS TF	NRS IL	NRS TF	p-value
Pre	8.91 ±0.21	8.76 ±0.10	8.80 ±0.32	8.65 ±0.21	0.001
15 min	7.23 ±0.47	5.16 ±0.36	7.12 ±0.58	5.05 ±0.25	
60 min	5.45 ±0.78	2.18 ±0.67	5.34 ±0.89	2.07 ±0.56	
6 hr	3.15 ±0.41	1.16 ±0.30	3.04 ±0.52	1.05 ±0.41	
24 hr	1.21 ±0.42	0.17 ±0.31	1.10 ±0.31	0.12 ±0.31	

Discussion:

The present study was carried out to compare the effectiveness of interlaminar and transforaminal cervical epidural steroid injection techniques in patients suffering from chronic neck pain with radiculopathy. The results show that both approaches are useful in reducing pain and improving patient outcomes. However, the transforaminal approach provided faster and more effective pain relief when compared with the interlaminar technique. The demographic profile of patients in both groups was similar, with no statistically significant difference in age or gender distribution. This comparability between the groups helps reduce the effect of confounding factors and strengthens the reliability of the study findings. Most patients belonged to the 51–60 years age group, which is consistent with the usual pattern of cervical spondylosis and degenerative disc disease, as these conditions become more common with increasing age [2]. Hemodynamic parameters remained stable in both groups throughout the study period. There were no clinically significant changes in pulse rate, blood pressure, or oxygen saturation. These findings are similar to earlier studies, which have shown that cervical epidural steroid injections are generally safe and well tolerated when performed under fluoroscopic guidance [4]. The absence of major hemodynamic changes also suggests that both interlaminar and transforaminal techniques do not negatively affect cardiovascular stability. The most important observation in this study was the difference in pain relief between the two techniques. Both VAS and NRS scores gradually decreased over time in both groups, showing that cervical epidural steroid injections are effective in relieving radicular pain. However, patients in the transforaminal group experienced quicker and greater pain reduction at all measured time intervals. The better outcome with the transforaminal approach may be due to its ability to deliver the drug directly near the affected nerve root. This allows a higher concentration of corticosteroid to reach the site of pathology, resulting in better control of inflammation and pain transmission [6]. In contrast,

the interlaminar approach deposits the drug into the posterior epidural space, where the spread may be more diffuse and less targeted [7]. These findings are supported by previous research. Wu *et al.* reported greater pain relief in patients receiving transforaminal injections compared with those receiving interlaminar injections and observed better functional outcomes and higher patient satisfaction with the transforaminal approach [9]. Cohen *et al.*, in a comprehensive review, also concluded that transforaminal injections provide better short-term pain relief in patients with cervical radiculopathy [10]. The rapid pain reduction seen in the transforaminal group as early as 15 minutes after the procedure highlights its usefulness in patients who need quick symptomatic relief. This can be especially helpful in individuals presenting with severe radicular pain. The marked pain relief observed at 24 hours further suggests that the transforaminal approach may provide a sustained therapeutic benefit. Although the transforaminal technique has clear advantages, it is technically more challenging and has been linked to rare but serious complications such as vascular injury and spinal cord infarction [11, 12]. In the present study, the use of real-time fluoroscopy and contrast agents helped reduce these risks, and no major complications were reported. This emphasizes the importance of proper technique, imaging guidance, and operator expertise in maintaining procedural safety [13–15]. The interlaminar approach, although less effective in providing rapid pain relief, remains an important and practical option. It is relatively simpler to perform and may carry a lower risk profile. It may be preferred in patients with multilevel involvement or in cases where anatomical factors make the transforaminal approach difficult or unsuitable. The findings of this study have important clinical relevance. The greater effectiveness of the transforaminal approach suggests that it may be preferred in patients with unilateral radiculopathy and clearly identified nerve root involvement. However, the final choice of technique should be individualized, taking into account patient characteristics, anatomical findings, clinician experience, and availability of imaging facilities. This study also has some limitations. The follow-up period was limited to 24 hours, so long-term outcomes could not be assessed. In addition, functional outcomes such as Neck Disability Index and return-to-work status were not discussed in detail in this section. Future studies with larger sample sizes and longer follow-up periods

are needed to confirm these findings and evaluate the long-term benefits of both techniques.

Conclusion:

Both interlaminar and transforaminal cervical epidural steroid injection techniques are effective in reducing pain in patients with cervical radiculopathy. However, the transforaminal approach provides faster and greater pain relief compared with the interlaminar approach. Hemodynamic stability and safety were similar in both groups. Therefore, the transforaminal technique may be considered a preferred option for targeted pain management in carefully selected patients.

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