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COMPARATIVE STUDY BETWEEN CAUDAL EPIDURAL STEROID INJECTION AND TRANSFORAMINAL BLOCK FOR POST-LUMBAR SURGERY SYNDROME

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ABSTRACT

Introduction: Post-lumbar surgery syndrome (PLSS) may result, often attributed to epidural fibrosis. Minimally invasive interventions like caudal epidural steroid injections (CESI) offer relief, especially when surgical revisions have high risks. Transforaminal epidural steroid injections (TFESIs) are commonly used and target-specific, effectively managing PLSS unresponsive to conservative therapies.

Materials and Methods: The study included 40 patients in each group (CESI and TFESI) who met specific criteria: aged 18-65, with a recent single-level nonfusion discectomy, evidence of epidural fibrosis (EF) on MRI, and persistent low back and leg pain unresponsive to conservative treatments. Exclusion criteria included multilevel EF, previous fusion surgery, recurrent disc hernia, and other spinal conditions. Numeric Rating Scale (NRS-11) and modified Oswestry Disability Index (mODI) were assessed before and after the procedure at various time points.

Observations and Results: Age did not significantly differ between CESI (M = 52.78 ± 7.99) and TFESI (M = 49.65 ± 9.79) groups (p = 0.122). The gender distribution did not significantly differ between the CESI and TFESI groups (p = 0.823). The distribution of ASA categories did not significantly differ between CESI and TFESI groups (p = 0.822). BMI did not significantly differ between CESI and TFESI groups (p = 0.195). Among the NRS scores, only the 1st day showed a significant difference between the CESI and TFESI groups (p = 0.033). The mean NRS score for CESI at 1st day was 0.23 ± 0.39, while for TFESI it was 0.45 ± 0.51. Significant differences in

Oswestry Disability Index scores were found at 6 hours ($p = 0.001$), 12 hours ($p < 0.0001$), 5th day ($p = 0.002$), and 1 week ($p = 0.002$) post-procedure, with CESI group reporting lower mean scores compared to TFESI at these time points.
Discussion: CESI offered quicker pain alleviation and enhanced early functional progress than TFESI, especially during the initial week. Both methods demonstrated comparable long-term results in pain and disability scores by the 3-month follow-up.
Conclusion: CESI provides better early symptom relief in PLSS, whereas CESI and TFESI are similarly effective over the long term. CESI might be favored for faster recovery, particularly in situations involving significant epidural fibrosis.

Keywords: Post-lumbar surgery syndrome, caudal epidural steroid injection, transforaminal block, mODI, NRS.

MANUSCRIPT

1. INTRODUCTION

Post lumbar surgery syndrome (PLSS) or failed back surgery syndrome (FBSS), is defined as persistent or recurrent low back and/or leg pain following anatomically successful spinal surgery. PLSS is multifactorial in etiology and consists of mechanical, inflammatory, and neuropathic factors. PLSS is often associated with epidural fibrosis, arachnoiditis, recurrent disk herniation, spinal instability, and altered biomechanics post-surgery; of these, the most common contributor, epidural fibrosis, reduces nerve root mobility and leads to recurrent inflammation. A comparable research published in Lancet by the global burden disease (GBD) 2016 collaborators on disease and injury incidence and prevalence indicated that worldwide, LBP, migraine, age-related and other hearing loss, iron-deficiency anemia, and major depressive disorder ranked as the top five causes of years lived with disability in 2016, with LBP contributing the most [1].

Clinically, patients with PLSS present with axial low back pain, radiculopathy, or both [2]. The diagnosis is primarily clinical, which is supported by imaging such as MRI[3], which reveals fibrotic changes or recurrent disc pathology. Management of PLSS involves a multidisciplinary approach, including pharmacological therapy, physical rehabilitation, and interventional pain procedures.

Epidural steroid injections, particularly through caudal and transforaminal routes, have been used to manage the symptoms by reducing inflammation and adhesions [4]. The choice of route and steroid combination is often tailored based on patient anatomy, symptomatology, and the presence of epidural scarring. Minimally invasive interventions like caudal epidural steroid injection (CESI) and transforaminal epidural steroid injection (TFESI) have shown promise in reducing pain and improving function [5], especially in patients who are poor candidates for revision surgery.

CESI allows for a broad epidural drug spread, which is advantageous in treating diffuse epidural fibrosis—a common cause of PLSS—by reducing inflammation and nerve root irritation. It is particularly useful in cases with multilevel scarring and is associated with a lower risk profile when performed under ultrasound or fluoroscopic guidance [6]

TFESI, on the other hand, delivers corticosteroids directly adjacent to the affected nerve root, providing more localized relief and higher drug concentration at the pathology site [7]. While TFESI is often preferred in cases of focal radiculopathy, its technical complexity and risks—such as inadvertent vascular or intrathecal injection—make it less favorable in certain PLSS patients.

The aim of this study is to compare the efficacy of CESI and TFESI in managing pain and disability in patients with PLSS.

2. MATERIALS AND METHODS

This prospective randomized clinical trial was conducted at the Department of Anesthesiology in a rural Hospital in South India from June 2023 to March 2024. Ethical clearance was obtained from the Institutional Ethics Committee prior to study initiation. All participants were provided verbal

and written information about the study, and informed consent was obtained before recruitment. A total of 80 patients who presented with persistent low back and leg pain following lumbar discectomy were screened. They were enrolled and randomized into two groups: CESI (Group C) and TFESI (Group T), each with 40 patients. The present study consisted of patients aged between 18 and 65 years who had undergone a recent single-level non-fusion lumbar discectomy and demonstrated MRI evidence of epidural fibrosis (EF). Eligible participants also experienced persistent low back and leg pain that had not responded to conservative management for a minimum of six weeks. Patients were excluded if they had multilevel epidural fibrosis, a history of spinal fusion surgery, recurrent disc herniation, or spinal deformities such as scoliosis or spondylolisthesis. Patients were randomized using a computer-generated sequence into two groups: Group C (CESI, n=40) and Group T (TFESI, n=40). All procedures were performed by the same pain specialist, who was not involved in follow-up assessments. Baseline demographic and clinical parameters such as age, gender, BMI, and pain duration were recorded. MRI T2-weighted axial images were assessed for epidural fibrosis. Pain intensity was measured using the Numeric Rating Scale (NRS-11) and modified Oswestry Disability Index (mODI) at baseline, 6 hours, 12 hours, Day 1, Day 3, Day 5, 1st week, 1st month and 3 months post surgery . Table 1 shows the Modified Oswestry Disability Index (mODI) which assesses the degree of disability related to lower back pain in daily activities. The score ranges from 0 to 50 with 10 questions on a scale of 0 to 5 each [8]. Treatment success was defined as a 50% or more reduction in NRS score. The radiologist and follow-up assessors were blinded to group allocation. In Group C, patients receiving Caudal Epidural Steroid Injection (CESI) were positioned face down with a cushion underneath the hips to highlight the sacral hiatus. Using ultrasound guidance with a curvilinear probe and following strict aseptic measures, the caudal epidural space was located. A 20-gauge needle was subsequently placed into the caudal space. After verifying the accurate positioning of the needle, 12 mL of a solution with 0.125% levoanawin and 40 mg of triamcinolone was given, as shown in Figure 1. In Group T, patients undergoing Transforaminal Epidural Steroid Injection (TFESI) were positioned prone. The transforaminal area at the L4–L5 or L5–S1 level was located with a curvilinear ultrasound probe. A combined approach utilizing both ultrasound and fluoroscopic assistance was used for precision. A needle was placed through an out-of-plane method, and its location was verified with C-arm fluoroscopy. A total of 4 mL of injectate—2 mL at each location—containing 0.125% levoanawin and 40 mg of triamcinolone was given, as shown in Figure 2. A clear consort diagram of this study is shown in Figure 3.

Total Score (out of 50)	Level of Disability
0–10	Minimal Disability
11–20	Moderate Disability
21–30	Severe Disability
31–40	Crippling Back Pain
41–50	Bed-bound or Symptom Magnification

Section	**Scoring Range**
1. Pain Intensity	0 to 5
2. Personal Care	0 to 5
3. Lifting	0 to 5
4. Walking	0 to 5
5. Sitting	0 to 5
6. Standing	0 to 5

Section	Scoring Range
7. Sleeping	0 to 5
8. Social Life	0 to 5
9. Travelling	0 to 5
10. Employment/Homemaking	0 to 5

Table 1: mODI assessment Scale

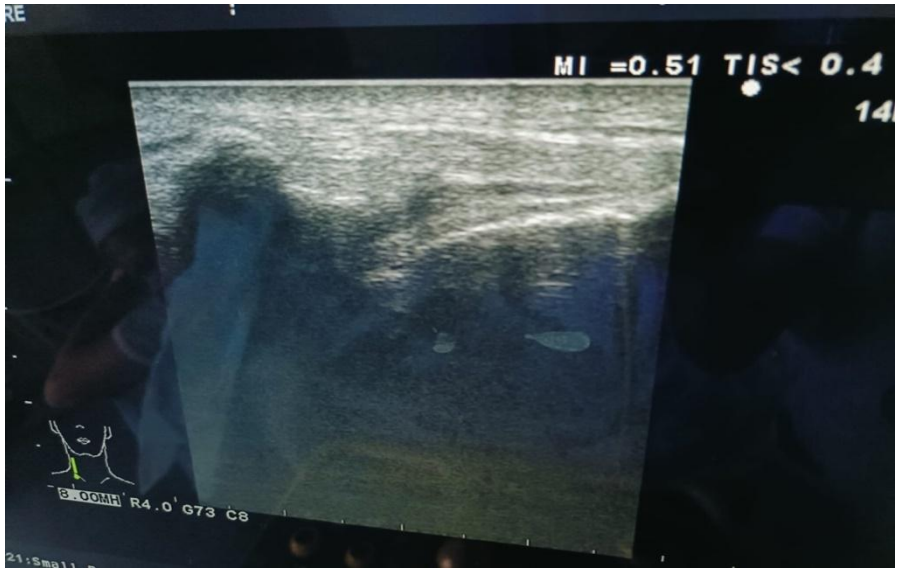

Figure 1: Caudal epidural space on an Ultrasound

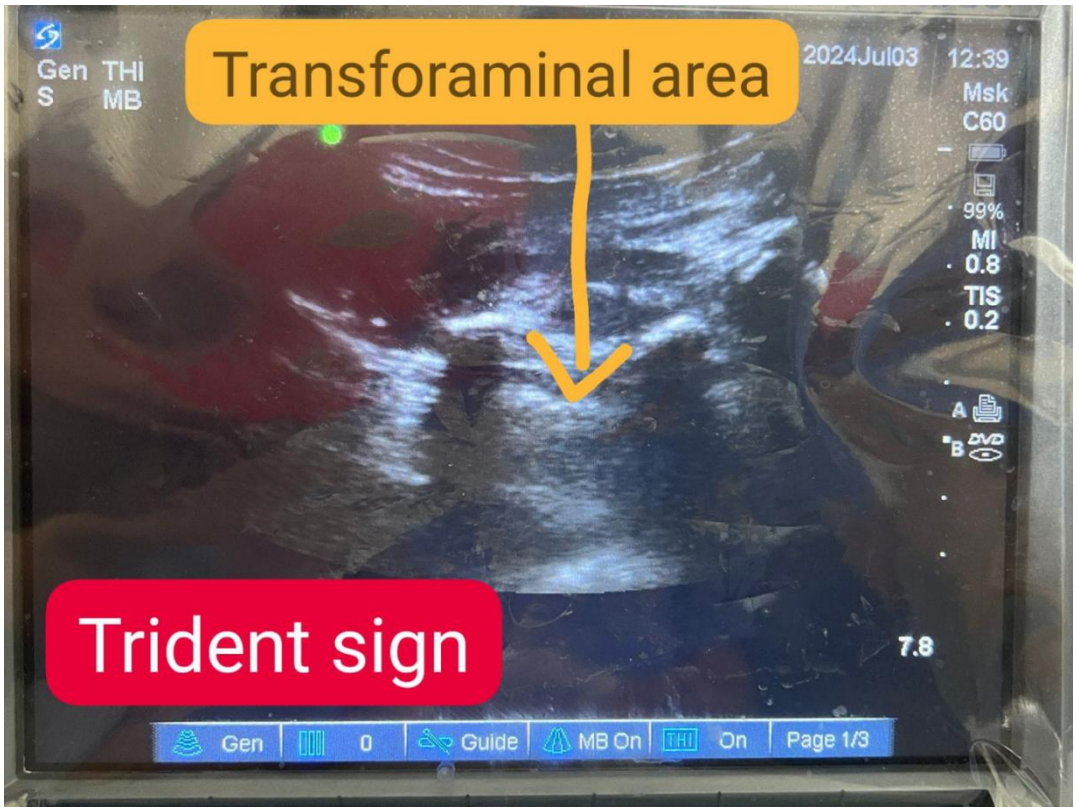

Figure 2: Transforaminal space as seen on Ultrasound

Statistical Analysis:
Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± SD and compared using the independent t-test. Categorical variables were analyzed using Chi-square test and a p-value < 0.05 was considered statistically significant.

CONSORT DIAGRAM:

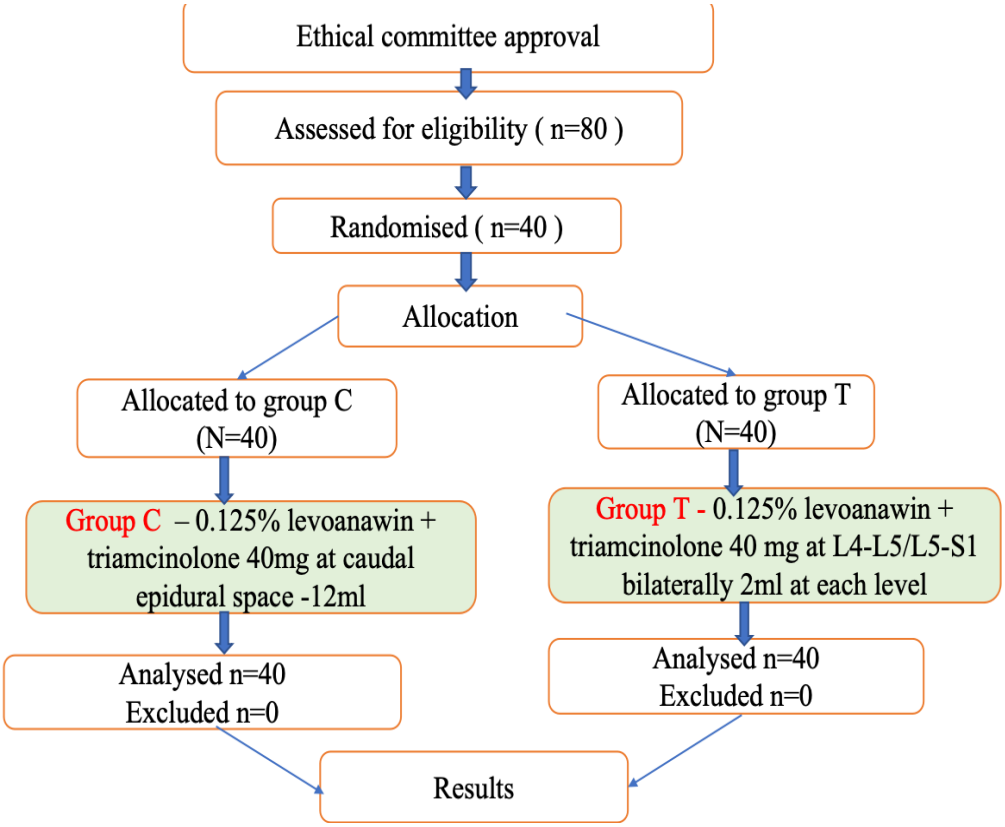

Figure 3: Consort Diagram of this study

3. OBSERVATIONS AND RESULTS

A total of 80 patients were included in the study, with 40 patients each in the CESI and TFESI groups. Baseline demographic and clinical characteristics were comparable between the groups, showing no statistically significant differences.

Variable	CESI (n = 40)	TFESI (n = 40)	p-value
Age (years, mean ± SD)	52.78 ± 7.99	49.65 ± 9.79	0.122
Gender (M/F)	24 / 16	23 / 17	0.823
BMI (mean ± SD)	26.2 ± 3.1	27.1 ± 3.4	0.195
ASA I / II	22 / 18	21 / 19	0.822

Table 2: Demographic Characteristics of Study Participants

Table 2 indicates that the baseline demographic and clinical characteristics, including age, gender, BMI, and ASA classification. There is no statistically significant difference seen in the patient's demographic and clinical characteristics between the CESI and TFESI groups.

Table 3: Comparison of NRS Scores between CESI and TFESI groups

NRS	CESI		TFESI		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	
1hr	0.03	0.16	0.13	0.40	0.149
6hrs	0.05	0.22	0.18	0.38	0.079
12hrs	0.20	0.41	0.35	0.53	0.161
1st day	0.23	0.39	0.45	0.51	0.033
3rd day	0.24	0.44	0.39	0.83	0.315
5th day	0.25	0.31	0.34	0.71	0.464
1week	0.23	0.42	0.31	0.48	0.43
1 month	0.39	0.64	0.43	0.87	0.815
3 months	0.45	0.63	0.51	0.45	0.625

Table 3 and Figure 4 indicate NRS scores at various time points from the 1st hour to 3 months, which shows no significant differences between the CESI and TFESI groups ($p > 0.05$) except on the 1st day, where the TFESI group reported significantly higher pain scores ($p = 0.033$).

Figure 4: NRS Scores at various time points between Group C and Group T.

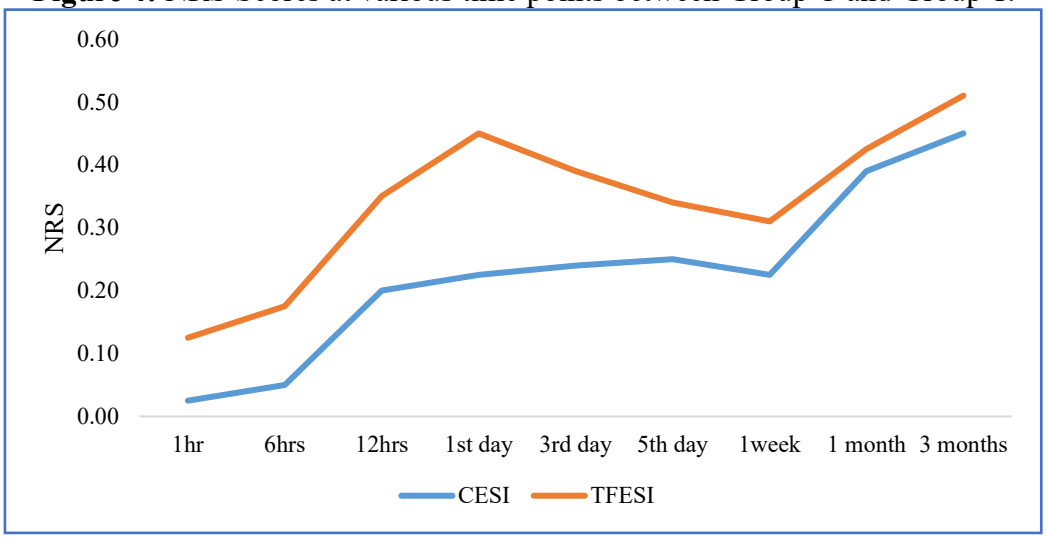

Table 4: Comparison of ODI Scores between CESI and TFESI groups

ODI	CESI		TFESI		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	
1hr	33.03	6.20	35.35	5.31	0.0761
6hrs	27.83	5.60	31.83	4.86	0.001
12hrs	26.01	5.08	29.68	4.39	<0.0001
1st day	24.08	4.60	25.73	3.83	0.085
3rd day	22.65	4.23	24.23	3.54	0.073
5th day	20.63	3.81	23.12	3.34	0.002
1week	19.63	3.64	21.95	3.08	0.002
1 month	22.48	4.09	23.03	3.49	0.519
3 months	25.80	4.75	27.55	4.13	0.082

Table 4 and figure 5 indicate the Oswestry Disability Index (ODI) scores at various time points from the 1st hour to 3 months, which shows no significant differences between the CESI and TFESI groups ($p > 0.05$), except at 6 hours, 12 hours, 5th day, and 1 week post-treatment. At these time points, the CESI group consistently reported significantly lower disability scores compared to the TFESI group ($p < 0.05$).

Figure 5: ODI scores at various time points between Group C and Group T

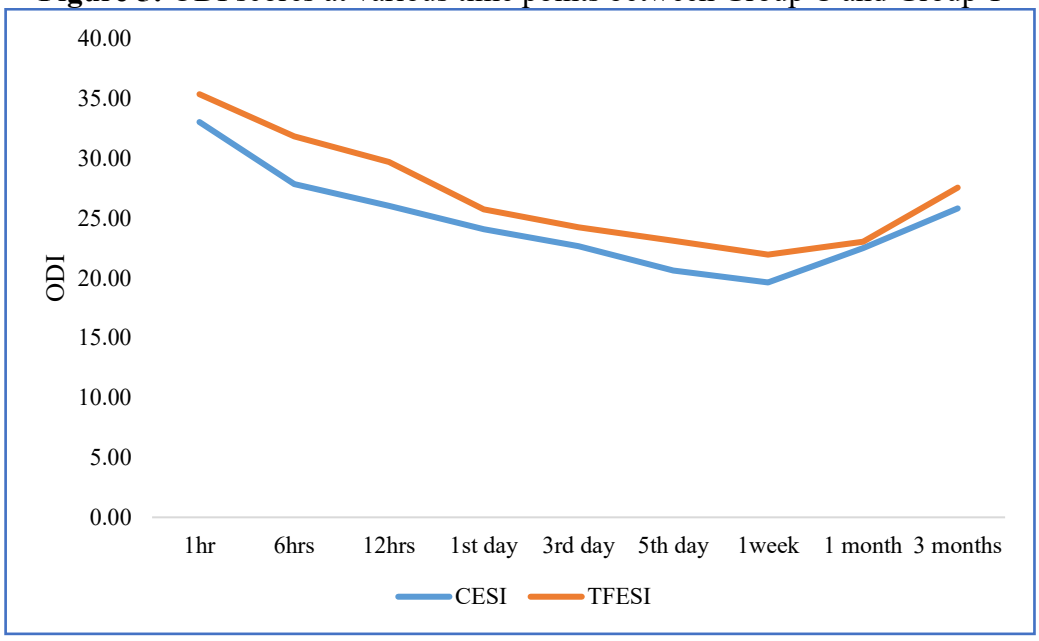

Table 5: NRS Score Reduction (3 months compared to baseline)

Group	1 hr	3 Months	Reduction	p-value
CESI	0.03	0.45	0.42	0.625
TFESI	0.13	0.51	0.38	

Table 5 shows the decrease in NRS scores from 1 hour to Day 1 and 3 months for each group. In the CESI group, the NRS score decreased from 0.03 to 0.23 on Day 1 (decrease = 0.20, $p = 0.033$) and to 0.45 at 3 months (decrease = 0.42, $p = 0.625$). In the TFESI group, the score decreased from 0.13 to 0.45 on Day 1 (decrease = 0.32) and to 0.51 at 3 months (decrease = 0.38).

Table 6: ODI Score Reduction (3 months compared to baseline)

Group	1 hr	3 Months	Reduction	p-value
CESI	33.03	25.80	7.23	0.082
TFESI	35.35	27.55	7.80	

Table 6 illustrates the decrease in ODI scores from 1 hour to Day 1 and 3 months across all groups. In the CESI group, the ODI score decreased from 33.03 to 24.08 on Day 1 (decrease = 8.95, $p = 0.085$) and to 25.80 after 3 months (decrease = 7.23, $p = 0.082$). In the TFESI group, it dropped from 35.35 to 25.73 on Day 1 (decrease = 9.62) and to 27.55 at 3 months (decrease = 7.80).

3. DISCUSSION

Our present study assessed 80 patients suffering from post-lumbar surgery syndrome, and they were evenly split into CESI and TFESI groups. Baseline attributes including age, gender, BMI, and ASA status were similar across the groups ($p > 0.05$), confirming uniformity in patient selection. Our

Study showed that both CESI and TFESI significantly alleviated pain over time, with a notable statistical difference observed on Day 1. The CESI group demonstrated a more significant NRS decrease (96.9% vs. 93.8%; $p = 0.033$), indicating quicker pain alleviation in the initial postoperative phase.

Functional recovery, measured with the Oswestry Disability Index (ODI), showed significant improvement in the CESI group at 6 hours, 12 hours, Day 5, and 1 week ($p < 0.05$), suggesting better early functional gains with CESI. During a 3-month follow-up, the two groups demonstrated similar decreases in NRS scores (0.42 for CESI compared to 0.38 for TFESI; $p = 0.625$), indicating similar long-term pain results. Likewise, ODI scores at 3 months showed no significant differences between the groups (reduction of 7.23 in CESI compared to 7.80 in TFESI; $p = 0.082$), suggesting that both interventions offer comparable long-term functional advantages.

Our study indicated that CESI resulted in notably enhanced early pain relief on Day 1 (NRS reduction: 96.9% compared to 93.8%; $p = 0.033$) and greater functional improvement at 6 hours, 12 hours, day 5, and 1 week ($p < 0.05$ for ODI). Conversely, Rosenberg's study in 2002 [9] indicated a mean decrease in pain scores from 7.3 to 3.4 at 2 months, 4.5 at 6 months, and 3.9 at 12 months among 82 patients receiving fluoroscopy-guided TFESI. At one year, over 50% pain relief was observed in 59% of discogenic patients and 67% of cases without MRI confirmation. Our research underscores quicker short-term alleviation with CESI, whereas Rosenberg's study pointed out prolonged long-term pain relief with TFESI.

A Study conducted by Lee et al in 2014 [10], indicated that Percutaneous Adhesiolysis (PA) outperformed TFESI in PLSS patients at the 6-month mark, showing more significant enhancements in NRS back, NRS leg, and ODI scores. Moreover, PA exhibited considerably improved outcomes in the decompression subgroup compared to the fusion subgroup. Our study backs CESI for initial recovery, whereas Lee et al. emphasized the greater long-term effectiveness of PA compared to TFESI, particularly in certain surgical contexts.

Akkaya et al in 2017 [11], evaluated ultrasound and fluoroscopy-guided caudal epidural steroid injections in postlaminectomy patients and observed comparable pain relief and functional enhancement in both groups over a 3-month period. The ultrasound-guided method took notably less time (6.06 ± 0.88 min compared to 11.2 ± 1.14 min), indicating improved efficiency and increased comfort for patients. Both studies endorse caudal techniques; however, ours focuses on early clinical effectiveness, while Akkaya's study underscored the procedural benefits of ultrasound guidance.

In 2016, Jun Liu's meta-analysis involving 664 patients [12] found that although TFESI had a improved results compared to CESI, the variations were neither clinically nor statistically significant. Both studies advocate for the application of TF and caudal techniques for radicular pain, yet our results emphasize a significant short-term benefit of CESI in the post-surgical context.

In 2015, Manchikanti et al. [13] examined 360 patients from three Randomized controlled trails and found that caudal, interlaminar and transforaminal techniques were all effective for lumbar disc herniation, with steroid groups demonstrating better results in pain relief and functionality, especially with interlaminar injections. At 2 years, caudal injections using steroids provided greater average pain relief per procedure. Our research demonstrates initial advantages of CESI in PLSS, whereas Manchikanti et al. underscores the enduring effectiveness of all epidural methods.

4. CONCLUSION

Both Caudal Epidural Steroid Injection (CESI) and Transforaminal Epidural Steroid Injection (TFESI) demonstrated efficacy in alleviating pain and enhancing function in individuals suffering from Post-Lumbar Surgery Syndrome (PLSS). CESI offered quicker pain relief in comparison to TFESI, demonstrating greater early clinical advancement. Functional results were also superior in the CESI group in the early postoperative phase. During the long-term follow-up, both CESI and TFESI demonstrated similar effectiveness in alleviating pain and promoting functional recovery.

CESI might be a better choice for patients needing faster relief, especially in situations involving extensive epidural scarring. Ultrasound-guided CESI is a reliable and efficient option for treating PLSS in clinical settings.

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