Randomized Controlled Trial

Cervical Erector Spinae Plane Block vs. Epidural Steroid Injection for Cervical Radicular Pain: A Clinical Trial

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Background: Cervical radicular pain is a common chronic pain syndrome, typically managed with conservative treatments. In patients unresponsive to conservative management, minimally invasive interventions, such as an interlaminar cervical epidural steroid injection (ICESI), are employed. The cervical erector spinae plane block (ESPB), initially utilized at the upper thoracic level, has shown promise for managing cervical radicular pain and may serve as an alternative to an ICESI.

Objective: Our study compared the efficacy of ICESIs and cervical ESPBs in patients with cervical radicular pain that was refractory to conservative treatment.

Study Design: A randomized, double-blind, controlled trial.

Setting: Rasool Akram Hospital, pain clinic and pain operating room, Department of Anesthesia and Pain Medicine, Iran University of Medical Science, Tehran, Islamic Republic of Iran.

Methods: In this randomized clinical trial, 30 patients with cervical radicular pain that was unresponsive to conservative therapy were randomized into 2 groups: ICESI Group and ESPB Group. Outcomes were assessed at baseline, and at the 2- and 8 weeks postprocedure follow-ups using the Neck Disability Index (NDI) and the Numeric Rating Scale (NRS-11).

Results: Both groups demonstrated significant reductions in pain intensity and improvements in functional status ($P < 0.05$). No significant differences in mean (SD) NRS-11 scores were recorded between the groups at 2 weeks (ICESI: 3.93 [1.87] vs. ESPB: 3.73 [1.98], $P = 0.778$) and 8 weeks (ICESI: 3.53 [2.92] vs. ESPB: 4.93 [3.06], $P = 0.211$). However, the ICESI group showed significantly greater improvement in mean (SD) NDI scores at both follow-up intervals (11.870 [6.812] vs 19.670 [7.715], $P = 0.007$, at 2 weeks; 10.070 [8.216] vs 19.000 [9.577], $P = 0.011$, at 8 weeks follow-up).

Limitations: The limitations of this study are its short follow-up times and small sample size.

Conclusion: Cervical ESPBs are as effective as ICESIs in reducing pain and improving function in patients with cervical radicular pain. Given its comparable efficacy and potentially fewer adverse effects, ESPBs may be considered a suitable alternative to ICESIs in this patient population.

Key words: Cervical radicular pain, cervical epidural steroid injection, clinical trial, erector spinae plane block, neck disability index

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Cervical radicular pain is a common condition frequently encountered in pain clinics, typically caused by intervertebral disc herniation, foraminal narrowing, inflammatory processes (radiculitis), or alterations in ion channel function (1,2). Patients often present with shooting or electric-like pain localized to the neck or radiating to the upper extremities. Diagnosis is based on clinical presentation, detailed physical examination, imaging, and electrodiagnostic studies (1).

First-line management includes conservative treatment with nonsteroidal anti-inflammatory drugs, anticonvulsants, and physiotherapy. For patients who do not respond to these measures, minimally invasive procedures may be considered. An interlaminar cervical epidural steroid injection (ICESI) is the standard initial interventional approach (3,4), while a cervical transforaminal epidural steroid injection is used to a lesser extent (5). However, an ICESI carries potential risks, including spinal cord or nerve root injury, intravascular injection, systemic complications, hematoma, and epidural infections. A cervical transforaminal epidural steroid injection is less commonly performed due to the risk of it also causing major complications (5). For patients who only get transient relief, pulsed radiofrequency of the dorsal root ganglia may be recommended (3).

The erector spinae plane block (ESPB), introduced in 2016 for thoracic neuropathic pain, has since been utilized as an alternative to paravertebral, thoracic, and lumbar epidural blocks in both acute and chronic pain management (6-9). A cervical ESPB, performed at the upper thoracic level, has been reported to successfully manage cervical radiculopathy (2). Due to its wider spread of local anesthetic to targeted neural structures, a cervical ESPB may offer a safer alternative to an ICESI, with potentially fewer complications. However, to date, no studies have directly evaluated the efficacy of cervical ESPBs in managing cervical radicular pain. In our study, we assessed the efficacy of cervical ESPBs in patients with cervical radicular pain and compared its outcomes with CESIs.

Methods

Study Design

Our study was designed as a randomized, double-blind, clinical trial. The study protocol was approved by the Ethics Committee of Iran University of Medical Sciences (Approval No: IR.IUMS.REC.1403.043) and conducted in accordance with the principles of the Declaration of Helsinki. The trial was registered with the Iranian Registry of Clinical Trials (IRCT20181011041308N5). A total of 50 patients aged from 30 through 70 years were initially enrolled; however, only 30 patients completed the study protocol and follow-up assessments.

Inclusion Criteria

Study eligibility criteria were: e age 30 through 70; an American Society of Anesthesiologists Physical Status Classification of I or II; positive results on the flexion compression, Spurling, and shoulder abduction tests, with normal sensory and motor examinations; with a diagnosis of cervical radicular pain without neurological deficits; And magnetic resonance imaging that showed stable nerve root compression due to degenerative changes or intervertebral disc herniation.

All patients had been refractory to at least 3 months of conservative treatment— including medical therapies such as nonsteroidal anti-inflammatory drugs, anticonvulsants, and physiotherapy—and were subsequently referred to the operating room at Hazrat Rasool Akram Hospital, located in Tehran, Islamic Republic of Iran, for interventional management.

Exclusion Criteria

Exclusion criteria were: a history of allergy to ropivacaine or triamcinolone; coagulopathy; substance abuse; pregnancy; malignancy; prior posterior or anterior cervical spine fusion surgery; psychiatric disorders; active infection; immunocompromised status; respiratory disease; spinal instability; cervical spinal stenosis; spondylolisthesis; or patient refusal to participate.

Randomization and Baseline Assessment

Patients meeting the inclusion criteria were randomized using block randomization into 2 equal groups: the ICESI Group (n = 15) and the ESPB Group (n = 15). Randomization was generated by an independent statistician at the clinical research development center using a simple random sequence with permuted blocks (http://www.randomization.com) of size 4 in a 1:1 allocation.

Each patient's assignment was sealed in an opaque, sequentially numbered envelope which was opened in the pre-anesthesia room by staff members (Sajede Salehi, Masood Mohseni).

The patients were blinded to their group assignment and then without assistance completed the Numeric Rating Scale (NRS-11: 0 = no pain, 10 = worst

imaginable pain) (10) and the Neck Disability Index (NDI: 0–4 = no disability, 5–14 = mild, 15–24 = moderate, 25–34 = severe, > 35 = complete disability) (11,12). The practitioners who assessed the results were also blinded to the group assignments.

Procedure

All procedures were performed with the patient prone. A pillow was placed under the chest to achieve cervical spine flexion. Standard monitoring, including electrocardiography, noninvasive blood pressure measurement, and pulse oximetry, were applied. The posterior cervical and upper thoracic regions were prepped and draped in a sterile fashion.

ESPB Technique

For patients in the ESPB Group, anteroposterior and slightly caudal fluoroscopic views were obtained. After identifying the C7 transverse process, a 22-G, 90-mm spinal needle was advanced toward the superolateral border of the C7 transverse process. Following bony contact and negative aspiration, 2 mL of iodinated contrast medium was injected, and contrast spread was confirmed under fluoroscopy. Subsequently, 15 mL of 0.2% ropivacaine mixed with 80 mg of triamcinolone was slowly injected. The bilateral ESPB was performed using the same technique.

ICESI Technique

In the ICESI Group, patients were also placed prone with a pillow under the chest to facilitate cervical flexion and improve visualization of the interlaminar spaces. Under fluoroscopy guidance, anteroposterior and slightly caudal views were obtained to identify the C7 vertebral body. After local skin anesthesia, an 18-G, 90-mm Tuohy needle was inserted at the C7 lamina using an interlaminar approach directed in a caudocephalad direction toward the epidural space at the C6–C7 level. The procedure was continued under lateral fluoroscopic view. The epidural space was identified using the loss-of-resistance technique.

After confirming epidural placement and negative aspiration for blood or cerebrospinal fluid, 2 mL of contrast medium was injected to verify an epidural spread pattern in a coaxial fluoroscopic view. Once correct needle placement was confirmed, 8 mL of 0.1% ropivacaine with 80 mg of triamcinolone was slowly injected. Throughout the procedure, continuous verbal communication with the patient was maintained to monitor for any neurological symptoms. At the procedure's completion, the needle was removed, and the patient was transferred to the recovery unit and monitored for 2 hours before being discharged.

Outcome Assessment and Follow-up

Pain intensity and functional status were evaluated using NRS-11 and NDI scores. Assessments were performed at baseline, and at postprocedure weeks 2 an 8. The physician assessing the data was blinded to each patient's group.

Statistical Analysis

A priori sample size calculation was performed based on an expected mean (SD) difference of 5 (7) in NDI scores between the 2 groups. With a significance level (α) of 0.05, a power (1–β) of 80%, and β = 0.2, a minimum sample size of 15 patients per group was determined to achieve statistical significance.

The normality of data distribution was assessed using the Kolmogorov-Smirnov test. For normally distributed continuous variables, comparisons between groups were made using independent sample t tests, and results were expressed as mean (SD). Categorical variables were reported as frequencies (percentages) and compared between groups using Pearson's χ^2 test.

Changes in NRS-11 and NDI scores over time and between groups were analyzed using repeated measures analysis of variance (ANOVA) with Pillai's Trace test to account for multivariate effects. Both within-subject factors (time) and between-subject factors (group) were analyzed to evaluate interaction effects and main effects over the follow-up period. Statistical significance was set at $P < 0.05$. Statistical analyses were performed using Stata version 17 (StataCorp LLC), with a 95% CI applied for all tests.

Results

A total of 50 patients with cervical radicular pain were assessed for eligibility. Twelve patients were excluded based on the exclusion criteria, and 8 patients declined participation. Consequently, 30 patients were enrolled and using block randomization were randomized into either the ESPB Group or the ICESI Group. All randomized patients were included in the final analysis, as shown in the Consolidated Standards of Reporting Trials (CONSORT) flow diagram (Fig. 1). Demographic variables, including age and gender, did not differ significantly between the 2 groups ($P > 0.05$) (Table 1).

A multivariate analysis revealed a significant effect of the within-subject factor "time" on both NRS-11 and

NDI scores. Specifically, for NRS-11, Pillai's Trace indicated a significant change over time (F(4.28)= 21.633; P = 0.006), with a large effect size (partial η^2 = 0.956) (Fig. 2). Similarly, for NDI, significant improvement was observed over time (F(2.14)= 11.294; P = 0.001), with a partial η^2 of 0.617, also indicating a large effect size (Fig. 3).

Both groups had significant pain reduction over time, as evidenced by the downward trend in NRS-11 scores (F(4.28)= 21.633; P = 0.006). The baseline difference in NRS-11 scores of the 2 groups were not significant. Additionally, no significant difference was found between the ESPB and ICESI Groups in NRS-11 scores at 2-week (P = 0.778) and 8-week (P = 0.211) follow-ups.

Both groups had functional improvement over time; there was a significant reduction in NDI scores (F(2.14)= 11.294; P = 0.001). However, baseline NDI scores were significantly different between the groups (P = 0.05); the ESPB Group initially had higher disability levels. At both the 2-week and 8-week follow-ups, the ICESI Group had significantly greater functional improvement compared to the ESPB Group (P = 0.007 and P = 0.011, respectively), suggesting superior functional outcomes with ICESI over the follow-up period (Fig. 3).

No immediate postprocedure side effects were reported as well as at the follow-ups in either group.

Discussion

Our study's findings show that cervical ESPBs performed at the C7 level are an effective treatment for managing cervical radicular pain, with comparable efficacy CESIs.

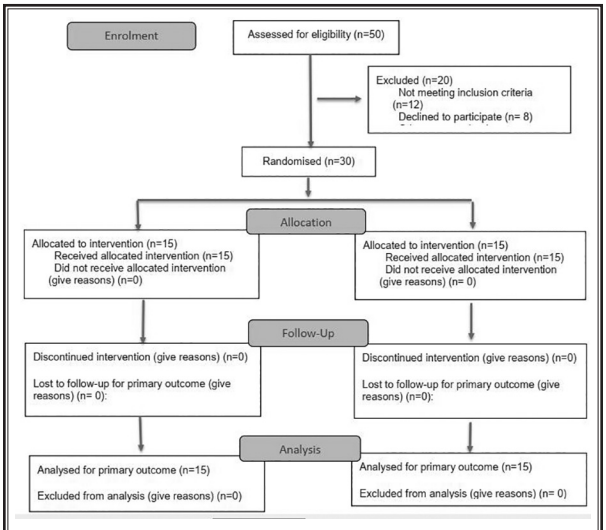


Fig. 1. *The Consolidated Standards of Reporting Trials (CONSORT) flowchart of the study.*

ICESIs are a well-established, minimally invasive procedure commonly performed on patients who have cervical radicular pain and who have not responded to conservative treatment (13-15). Although generally safe, ICESIs may cause severe complications, including direct vascular injury, neural damage, dural puncture, intrathecal injection, spinal cord infarction, stroke, and, in rare instances, death (16-21). Despite the low incidence, the potential severity of these complications warrants consideration of alternative techniques with safer profiles.

The ESPB is a relatively recent innovation in regional anesthesia, initially described for thoracic neuropathic pain management. The ESPB targets the fascial plane between the erector spinae muscles and the transverse processes, providing extensive analgesia through the spread of local anesthetic to both the dorsal and ventral rami of spinal nerves (22-26). The cervical erector spinae muscles — spinalis cervicis, longissimus cervicis, and iliocostalis cervicis — are anatomical targets for this block (27). The spread of local anesthetic is thought to extend anteriorly to the paravertebral space and potentially influence the sympathetic chain, although this mechanism remains under debate (28-31).

This mechanism provides effective analgesia while avoiding deeper, more invasive procedures such as CESIs (32,33). The ESPB has several safety advantages: its superficial location places it at a distance from critical spinal structures, and the large, compressible nature of the injection space permits safer administration in patients with coagulopathy (34).

Clinical observations suggest that 3–5 mL of local anesthetic is sufficient to block a dermatome; an injection of 30 mL at the T2 level can spread to C3 (35,36). Based on these findings, we used 15 mL bilaterally in our study.

Several studies support the feasibility and safety of a cervical ESPB. Cadaveric studies have shown that injecting 20 mL of contrast medium at the C6-C7 level results in cephalad spread to C4 and caudal spread to T1, successfully staining nerve roots and supporting its use for cervical and shoulder procedures (37). In clinical practice, a 2021 study (38) on 6 patients undergoing shoulder arthroscopy showed that a cervical ESPB provided sufficient intraoperative analgesia without complications such as hypotension, diaphragmatic paresis, or motor weakness. Additionally, a 2023 case report (39) described the use of

Table 1. *Descriptive statistics for the ICESI and ESPB groups across six variables: Numeric Rating Scale (NRS-11) scores at baseline, and postprocedure weeks 2 week and 8; Neck Disability Index (NDI) scores at baseline, and postprocedure weeks 2 and 8. .*

	Variable	Demographics		Test	*P* Value	F Value	95% CI	
		ICESI Group	ESPB Group				Lower	Upper
Gender	Men	3 (20%)	4 (26.7%)	0.18	0.66	0.175	-0.26	0.393
	Women	12 (80%)	11 (73.3%)					
	Total	15	15					
Age, yrs Mean (SD)		52.73 ± 12.72	60.33 ± 15.14	-1.488	0.148	2.215	-18.06	2.86
NRS-11	Baseline	7.87 ± 1.885	8.60 ± 1.502	-1.178	0.249	1.389	-2.008	0.541
	Postprocedure week 2	3.93 ± 1.87	3.73 ± 1.981	0.284	0.778	0.081	-1.241	1.641
	Postprocedure week 8	3.53 ± 2.924	4.93 ± 3.058	-1.281	0.211	1.642	-3.638	0.838
NDI	Baseline	25.20 ± 7.821	31.67 ± 9.875	-1.988	0.05	3.953	-13.129	0.196
	Postprocedure week 2	11.87 ± 6.812	19.67 ± 7.715	-2.9	0.007	8.615	-13.244	-2.356
	Postprocedure week 8	10.07 ± 8.216	19.00 ± 9.577	-2.742	0.011	7.519	-15.607	-2.260

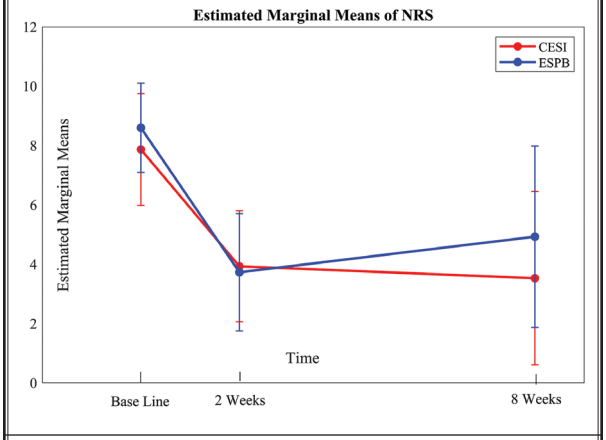


Fig. 2. *Mean (SD) Numeric Rating Scale (NRS-11) scores at 3 time points: baseline, postprocedure week 2, and postprocedure week 8.*

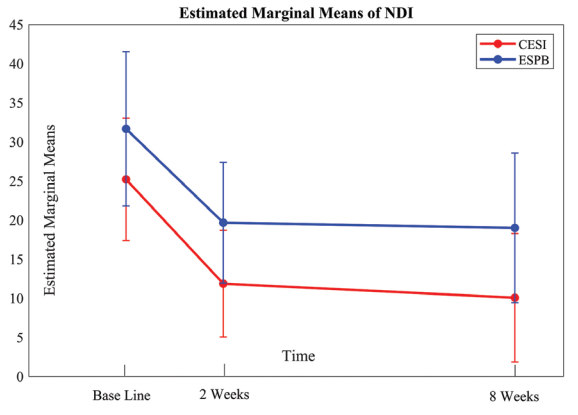


Fig. 3. *Mean (SD) Neck Disability Index NDI at 3 time points: baseline, postprocedure week 2, and postprocedure week 8.*

continuous cervical ESPB for postoperative analgesia in thoracic outlet syndrome surgery, highlighting its safety and effectiveness.

Furthermore, ESPB has shown promise for postoperative pain management post cervical and thoracic spinal surgery; a 2021 case series (40) reported stable hemodynamics and patient satisfaction. In 2019, a case report (41) documented successful use of bilateral cervical ESPBs for posterior neck surgery; it also reported effective intraoperative analgesia without adverse effects. Farooq and Wierzejski (42) reported that they observed that cervical ESPBs may reduce diaphragmatic excursion, particularly when administered bilaterally, but no clinically significant respiratory dysfunction occurred. As a precautionary measure, we excluded patients with preexisting respiratory conditions and implemented mandatory 2-hour postprocedural monitoring in the recovery unit before discharge.

Of particular relevance, a 2023 clinical trial (2) involving 82 patients with cervical radiculopathy compared cervical epidural injection with thoracic ESPB (noting that only a local anesthetic, without steroid, was injected in these patients) (2). The study found no significant difference in pain and disability outcomes between the 2 groups at postprocedure week 8, but an ESPB was recommended as a safer alternative due to its lower complication risk. Our findings align with this recommendation, showing that a cervical ESPB

provides comparable pain relief and functional improvement to CESI, with no observed serious adverse events.

Conclusion

In conclusion, a cervical ESPB at the C7 level appears to be an effective and safe alternative to an ICESI for managing cervical radicular pain. Our study shows there is comparable efficacy between the 2 techniques in terms of pain relief and functional improvement, with ESPB offering a potentially lower risk of adverse effects. Given its favorable safety profile and effective analgesic outcomes, a cervical ESPB may serve as a viable treatment option for patients with cervical radiculopathy, particularly for those seeking a less invasive alternative to an ICESI. Further studies with larger sample sizes and longer follow-up periods are warranted to confirm these findings and evaluate the long-term efficacy of ESPBs in managing cervical radicular pain.

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